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FEBRUARY 1983
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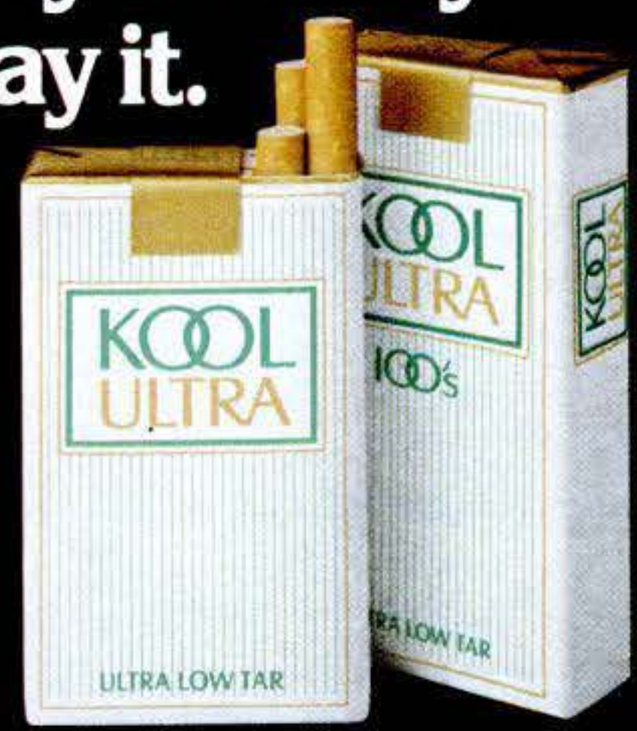

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PS READERS TALK BACK

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Nola talks back

References to the NASA power-factor controller (PFC) in the article "Power Saver" [PS, Nov. '82] seem to imply that all effort on the device ceased after a patent for the basic concept was issued five years ago. To the contrary, the problems mentioned were solved soon after public interest was shown, and I have received or applied for 12 patents relating to single- and three-phase PFCs. The NASA PFC has been successfully marketed by many of the more than 200 firms that were granted cost-free licenses to manufacture the device.

There are, in addition, at least six other types of motor-power savers being marketed, including the Parker device you reported on. I have tested most of these and have found none that can equal the performance of the PFC when all factors are considered, including ability to soft-start a motor, stable operation at near-zero inertial loads, maximum energy savings over the entire load range, ability to respond to sudden change in load, and ease of manufacture. Also, most of the other systems are sensitive to the amplitude of the current. This means that, in critical applications, one spare controller may be required for each size of motor. The NASA PFC is insensitive to current amplitude and one spare controller of a given horsepower rating will serve any motor of lesser or equal horsepower with no sacrifice in performance.

Frank Nola
Marshall Space Flight Center
Huntsville, Ala.

Parker states that its technology will not likely be used in household appliances because of the non-motor electrical devices they contain. But if this system can be reduced to "small black boxes or even microchips," as the article states, why can't it be direct-wired into the appliance where it will control only the main motor and not the peripheral electrical circuits?

Ray S. McAllister, Ames, Iowa

E. F. Lindsley replies: "We gave an erroneous impression about the PFC. For the record, Nola's power saver is being widely—and successfully—used. Reader McAllister is correct that the ideal way to use such devices would be to build them into the motor, and this is the route Parker is taking. The company is avoiding the household market because of limited suitable applications. Remember (from our previous coverage) that refrigerator motors, which are closely matched to a specific compressor load, are about the worst possible application for a power saver."

Hot focus

Sorry, Mr. Smyth, but your "Geodesic Solar Concentrator" [PS, Dec. '82] does not have "a concentration ratio of about 900 suns," even though you use 900 little mirrors. It would if your target were four inches square and every one of those mirrors were focused exactly on target. In that case, your target would melt unless it were made of ceramic. Assuming from the photos that the target is 15 inches square and that none of the mirrors misses at all, you still wind up with a very respectable 57 suns. Congratulations, though, on your design. I have been working on a similar project using an eight-by-16-foot mirror array, and my design has proved susceptible to high winds.

Thomas Scanlon, Lynbrook, N.Y.

Jerry Smyth tells PS that the dispute over concentration ratio is one of semantics. The reader is right if the ratio is figured as the average intensity on the target. However, his circular reflector produces the greatest intensity in the central two-inch-dia. area of the 16-inch-square target. There, the concentration ratio is close to 900 suns, and in fact holes have been burned through some 12-gauge-steel targets.

Attention, inventors

I'm still getting letters and calls about your five-year-old article "Help for Inventors" [PS, May '78], and more than 20,000 total inquiries from PS readers have been received by the old Oregon Innovation Center, so I thought I'd bring you up to date. Several Canadian and U.S. universities [RTB, PS, May '82] have implemented the Preliminary Innovation Evaluation Service (PIES) developed in the original program. Evaluation assistance is also available in the private sector through the Innovation Institute (2265 Shields Ave., Eugene, Ore. 97405), of which I am director. In addition to evaluation, we can offer limited new-venture, technology-transfer, and business assistance. Deserving inventors are also referred to other programs through our Innovation Network. In less than a year we've helped to launch five new ventures. One of them isn't going to stay small very long.

Gerald G. Udell, Director
Innovation Institute, Eugene, Ore.

New energy answer

Jan Kreider's answer about retrofit insulation of walls ["Alternate-Energy An-

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PS readers talk back

[Continued]

swers," PS, Nov. '82] does not warn about putting a vapor barrier on the exterior side of the additional insulation. Installation of six-mil Visqueen could cause some problems.

John J. English
Rutherford, N.J.

Jan Kreider replies: "Yes, I should have noted that a breathable infiltration barrier such as Du Pont's Tyvek, not an impermeable vapor barrier, is the proper material for this application."

Domestic ceramic

Your article on ceramic diesel engines [PS, Dec. '82] gave the unfortunate impression that Japanese companies have pioneered this development. The Cummins Engine Co. started work on this concept many years before the Japanese and still seems to be far ahead of them in this technology.

Robert K. Catterson
V.P. of Research
Briggs & Stratton, Milwaukee, Wis.

Our March '82 cover story on ceramic engines noted the Cummins work. The follow-up was intended to report developments from across the Pacific.

More than it can chew

I was surprised at William J. Hawkins' statement ["New Personal Computers," PS, Nov. '82] that "not much 16-bit software has been written yet." The DEC PDP-11-series computers, introduced in 1970, use 16-bit central processors. A large software library, including operating systems, multiple languages, and a variety of scientific, engineering, statistical, and business-application programs, is available.

Linda F. Milliguay
Cambridge, Vt.

Hawkins seems completely unaware of the 16-bit Texas Instruments TI-99/4A home computer. Over 1,000 business, engineering, scientific, financial, educational, and game programs run on it.

Gary Sprunk
Phoenix, Ariz.

William J. Hawkins replies: "The statement referred only to the 'new' personal computers discussed in the article. By the time you read this, a great deal of 16-bit software will be reaching the market."

Smart defenses

By describing the Phalanx antimissile weapon as a "system of last resort" [PS, Oct. '82], I feel that you left readers with the impression that U.S. surface ships are unprotected against low-flying missiles. In fact, the Vulcan/Phalanx is a very deadly weapon. First, it fires very quickly (3,000 or 6,000 rpm), and it uses uranium subcaliber projectiles that will penetrate anything. Equally important, it's smart. Two co-mounted, computer-controlled radar sensors continuously track the incoming target and follow the outgoing rounds. Anything flying into this defense system is heading for instant destruction. As of 1981, 400 Vulcan/Phalanx units were to have been made for 239 ships.

Mike McAvoy
North Georgetown, Ohio

Ocean-floor radar

Two points need to be clarified about your article "Synthetic Aperture Radar" [PS, Sept. '82]. Though NASA and NOAA withdrew sponsorship of the Nantucket shoals experiment, this important scientific endeavor has not been canceled. The Naval Research Laboratory (NRL), with some support from the Office of Naval Research and participation from a variety of other agencies, is proceeding with a series of experiments aimed at explaining the unexpected ability of SAR to resolve ocean-floor features. This program involves in situ remote-sensing experiments as well as theoretical and laboratory studies.

Also, while no new U.S. SAR-equipped oceanography satellite is now scheduled, an L-band SAR was carried aboard the second mission of the space shuttle and another is planned to go into orbit in 1984 as part of the space shuttle #17 payload. That flight will be coordinated with an NRL remote-sensing experiment.

Davidson T. Chen, Gaspar R. Valenzuela
Naval Research Laboratory
Washington, D.C.

Wrong theater

People interested in space development ["It's Time to Stop the Space Retreat," PS, Oct. '82] should spend more time in the lab than in hazy political battles over that which has not yet occurred.

David Johnston
Tucson, Ariz.

Between the lines

Thank you for your fine review of the Smith-Corona TP-1 Text Printer ["Bits & Bytes," PS, Sept. '82]. However, one technical error appeared: The TP-1 does tie together the carriage-return and line-feed commands. That is, whenever a carriage-return command is received by the printer, it automatically also performs a line feed. To prevent a double line feed, the printer is programmed to ignore any line-feed command issued by the computer that immediately follows a carriage-return command.

Mort Gutman, Dir., Printer Marketing
Smith-Corona Div., New Canaan, Conn.

Corrections: The Dornier 228 aircraft ["10 Hot New Planes," PS, Dec. '82] is produced in Germany, not France.

Due to devaluation of the French franc, the prices of the Aldes-Riehs heat exchangers ["Heat-Saving Vents," PS, Jan.] have been reduced. The model VMPH is now $1,308, the VMPI-5 is $1,642, and the VMPI-7 is $1,746.

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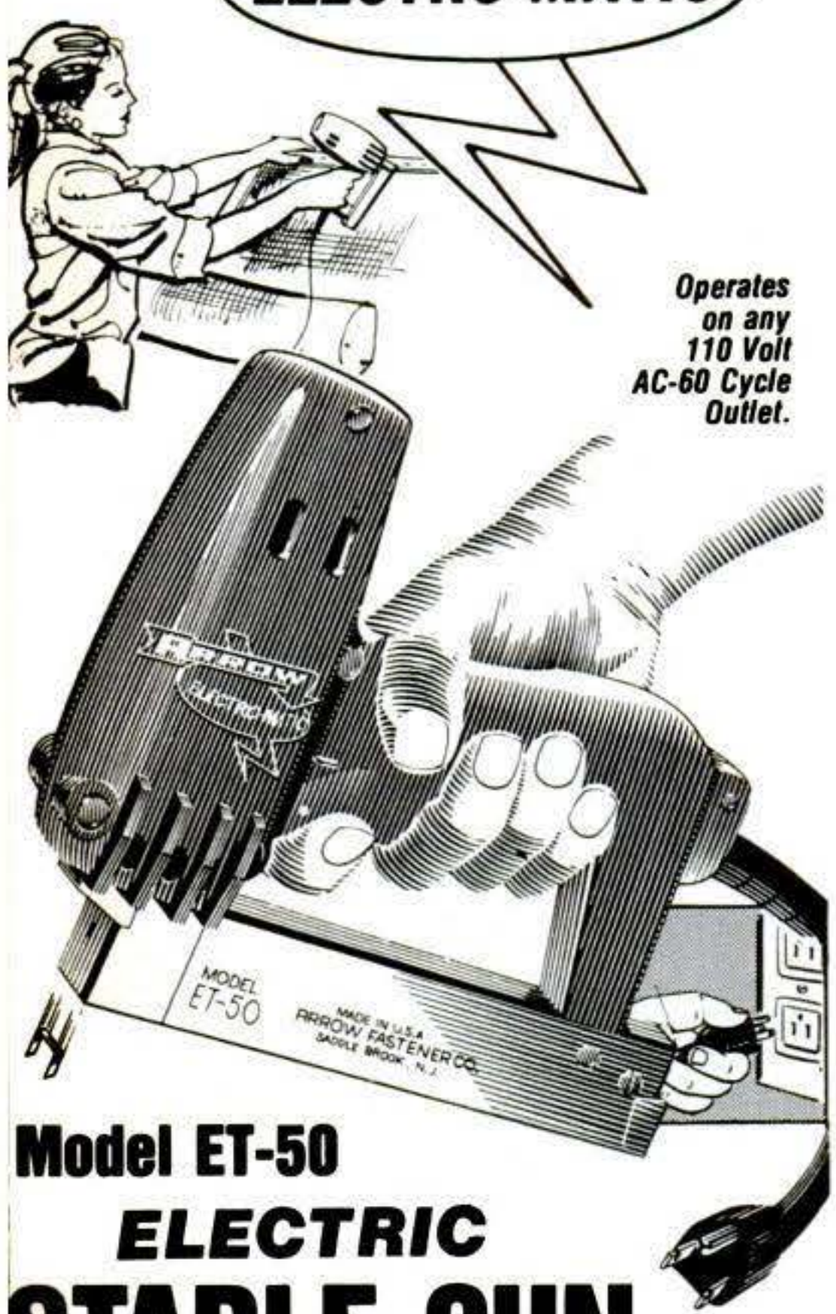

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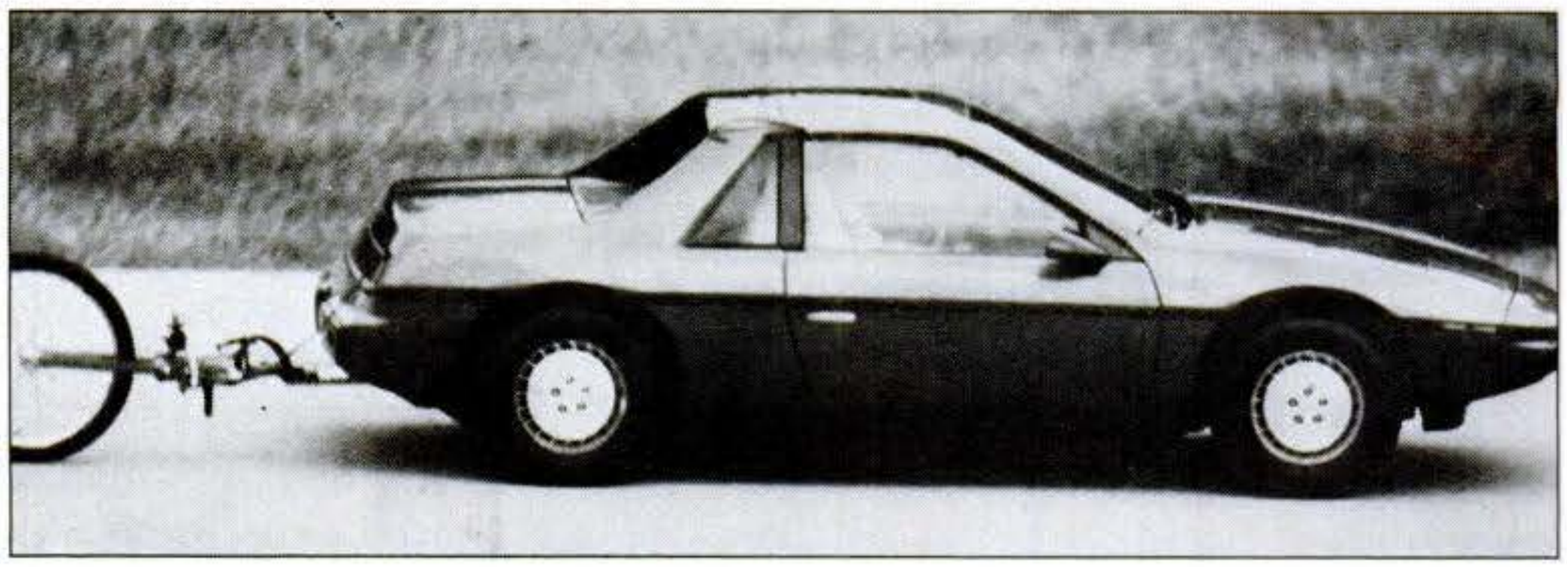
By JIM DUNNE



Inside the Fiero

Pontiac's two-seat P-car, to be named Fiero, is set for introduction next fall as a 1983 model. The P-car's mid-engine layout marks a design departure from anything GM has ever done. The plastic body panels laid over a metal sub-body are also a first for GM. Up close, the car is just as interesting. Sitting inside it is like sitting in the British TR7 sports car. The windshield is set far forward of the driver, and there is plenty of legroom, thanks to the behind-the-seat placement of the engine. A high, boxy spine runs down the center of the car at about elbow level to the driver. Atop this is the four-speed shifter and electric window switches. The shift lever is set at the driver's right hand in a comfortable position. Its throws are extra-short with no more than four inches from first-to-second or third-to-fourth gears. This is for close communication with one of three engine choices: a 2.5-liter (153 cu. in.) push-rod four, a turbocharged 1.8 (112 cu. in.) with multi-point fuel injection, and a V6. Passengers sit down low, and that leaves plenty of headroom. Some storage room is provided behind the seats, but the main trunk is behind the engine at the rear. This is an oddly shaped, oversize "pocket" that's big enough to hold a three-suiter plus some loose baggage. Up front, under the hinged hood, is a storage area similar in capacity to the old VW Beetle's. Pontiac executives are still talking about an $8,500 price tag for the X1/9-based Pontiac, but don't be surprised to see prices start at just under $10,000. "We expect to build as many as 140,000 a year," a Pontiac spokesman told me. Could be, but the price will have to compete favorably with Firebird's for that to come true.

Air sprung

Look for the first air suspension on an American car since the late 1950s to show up on the 1985 Lincoln Mark VII. Goodyear has developed a practical air spring. It's actually a rubber bag shaped like a skinny barrel. An on-board air compressor will automatically keep the bags inflated to the correct pressure. Later, if not initially, the driver will have the choice of inflating the springs to a higher or lower pressure to take advantage of different spring rates for varying road surfaces. That way the springs can provide either a soft, boulevard ride or a firm ride for better handling. One extra benefit is the ability to lower the ride height of the car by reducing the air pressure. This offers an immense advantage in aerodynamics. Lowering reduces the frontal area of the car and eliminates much under-car turbulence. Air springs were dropped from GM, Ford, and Packard models in the late 1950s after a year of production because the air systems could not maintain pressure. "We were just not ready for them then," Pontiac's former chief engineer Steve Malone told me. "But the new systems work just fine."

25 grand for a Vette?

That's the price Chevy is expected to ask for its all-new 1983 Corvette when it makes its appearance in another month or so. Too much? Chevrolet's general manager Bob Stempel doesn't think so. "Look at the price of our Corvettes now; they're going out at about $20,000. Then look at what they're asking for a Ferrari [$50,000+]. We think buyers will be willing to spend the extra $5,000 when they see what we have to offer." Among the things you'll see are lightweight alloys used extensively in the suspension and drive train, a new front suspension, and a cornering ability of 0.9 *g*s. That's the best in the industry for a production car. It sounds like a serious car, Mr. Stempel. A very serious car.

1985 Cutlass styling

A look at the 1985 Cutlass Supreme shows that the upright rear-window styling theme will be around for at least the

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rest of the 1980s. The new four-seat luxury car, which shares its body with Grand Prix and the Regal two-door, will have front drive and be at least a foot shorter. It will be based on Firenza's J-car chassis, but the wheelbase will be stretched two inches. Using the J chassis means front-wheel drive for the first time in this model. The rest of the styling? It has a long hood and short, high trunk, and the grille is placed down low—close to the bumper. Overall, though, the prototype looks unimpressive, especially at the rear, where the trunk and backlite impart a chopped-off appearance.

Compact vans

The front-drive passenger van Chrysler is preparing for next year will put that company alone in the compact-van field, since neither Ford nor GM has a similar model in the works. Chrysler will use the K-car front-drive system for its van, starting in 1984. But in 1985, Chevy's new van will have front engine and rear drive, the same layout used now. Chevy's van looks the same outside as the current one, except that the body is stubbier, thanks to the foot-shorter overall length. Prototypes are four-door; the doors look like those on the Chevy Suburban. This may indicate that two models will be combined in the new body—van and compact Suburban.

A-body wagon

GM will add a station wagon to its mid-size-car lines next year before dropping the wagons from the G and B lines. The new Celebrity/Ciera/Century/6000 wagons will have front drive. A unique part of the rear-end design is a vent window at the extreme rear of the greenhouse. The rear door will be a hatch type. The wagons join two- and four-door sedans, which have already been introduced.

Turbo wave

Turbocharged four-cylinder engines will return performance to high-volume small cars. A number of manufacturers have turbos on the drawing board or in production, and the trend toward high performance will continue for the foreseeable future. Pontiac has a turbo version of the 1.8-liter (112 cu. in.) Brazilian engine now used in the Pontiac 2000 ready for 1984. This engine should also show up in the Pontiac Fiero as an option. Ford has revived its on-again-off-again turbo 2.3-liter (140 cu. in.) engine and will make it available in a number of car lines, including Tempo/Topaz, LTD/Marquis, and Mustang/Capri. Chrysler will have a turbo option in the G-24 sports car next fall. The Europeans—Audi, Mercedes, Saab, Fiat, Volvo, Renault—have been offering turbos for a number of years, and more are on the way from VW. Nissan, Toyota, and Honda are in on the turbo blitz, too. Why? Problems with durability are mostly solved, and the turbo brings back the performance buyers are demanding while allowing almost all the advantages of small-engine fuel economy. PS

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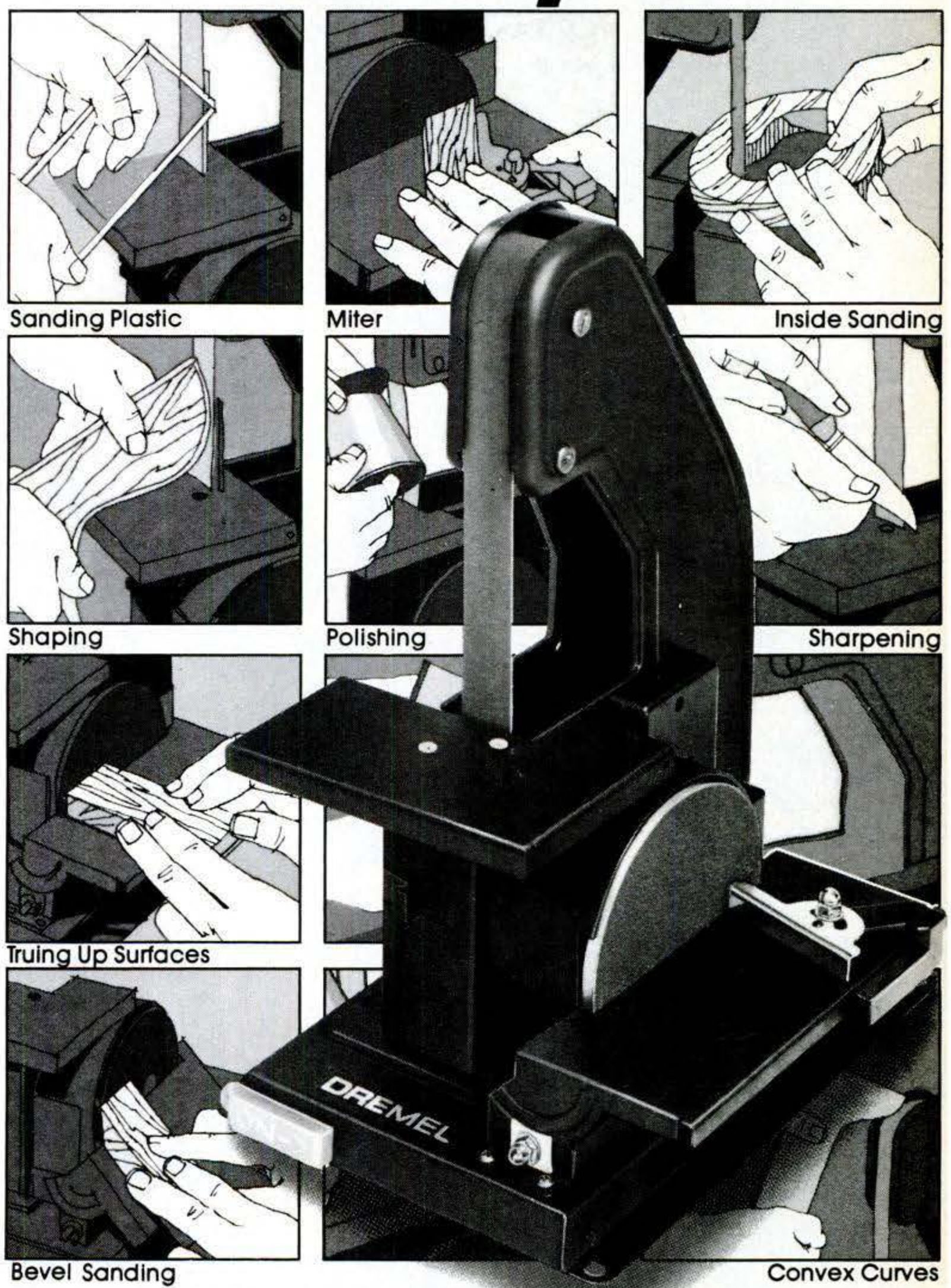

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SCIENCE NEWSFRONT

By ARTHUR FISHER

Sun-powered high flyer

An extraordinary unmanned aircraft is being designed for possible use in the 1990s. Shown in the artist's concept below, it is called the solar High Altitude Powered Platform (HAPP). Its function: to loiter at 70,000 feet for months at a time, deriving enough electric power from its solar cells to drive its large propeller and maintain station.

The design methodology for the HAPP concept is being developed by Lockheed Missiles and Space Company under a nine-month contract with NASA's Langley Research Center in Virginia. The space agency is contemplating applications for HAPP that include monitoring crops in California's Central Valley for the U.S. Department of Agriculture.

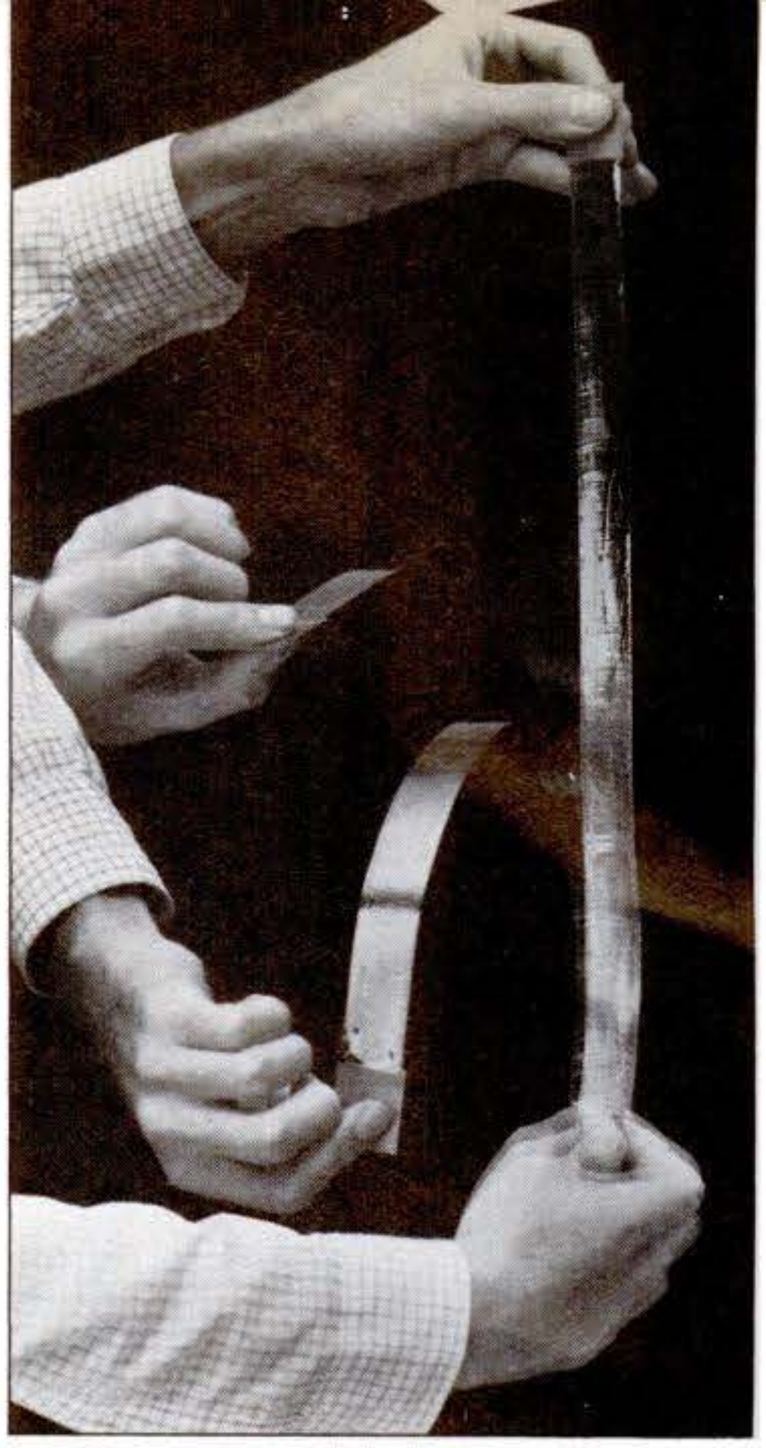
Photovoltaic solar cells cover both sides of the vertical stabilizers and both sides of the wing tips. During the day, the wing tips hinge up to receive the maximum amount of sunlight. At night, the HAPP wing tips revert to horizontal for best aerodynamic performance, and the craft runs on fuel cells charged during daylight.

Lockheed designers say the wingspan could range from 150 to 300 feet, and the weight from 1,000 to 3,000 pounds. Wing loadings would be less than a pound per square foot through the use of light, strong, graphite-epoxy structures, together with Mylar and Teflon coatings on the aluminum wing structure. The central pod would carry a 100-pound instrument package containing various sensors for monitoring.

One possible launch site for the solar HAPP is Palestine, Tex., where the U.S. Weather Bureau maintains enough data to predict the weather days in advance. That's important because of the special requirements of the aircraft. It would best be launched on fuel-cell power at 3 a.m., when winds are calmest. It would then take four hours to spiral up to 70,000 feet, recharging the fuel cells as the sun came up. The plane could achieve speeds of about 75 knots to reach and maintain station between 60,000 and 80,000 feet, where upper-level winds are lightest, and could remain there for months.

Alcohol in France

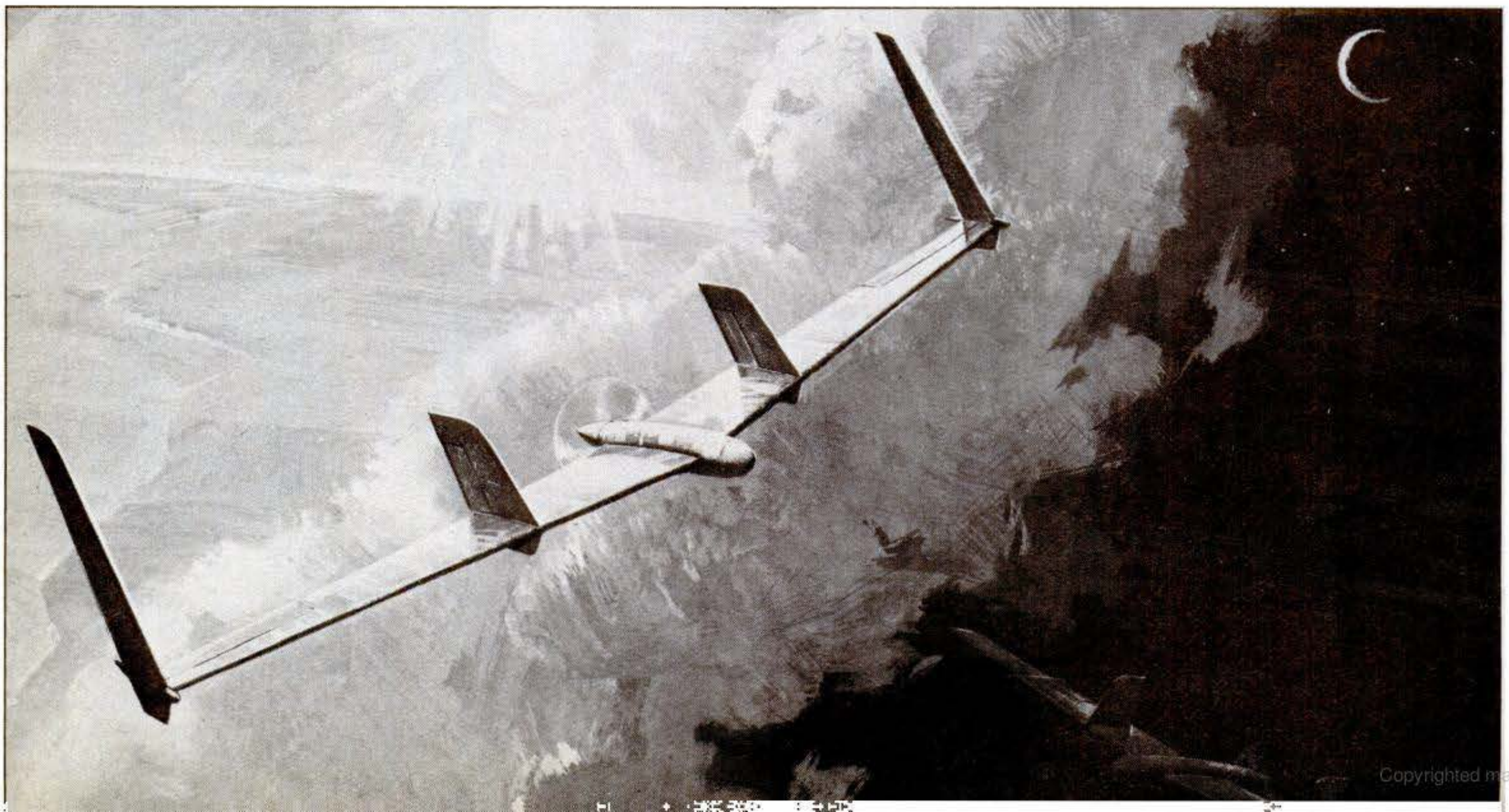
Wine consumption in France, whose citizens once could be described as viewing life through rosé-colored glasses, has dropped precipitously, according to a study by the French National Institute of Agricultural Research and the National Office of Table Wines. It declined from 120 liters per capita in 1964 to 90 liters by 1981. In fact, France is one of the few major countries whose total alcohol consumption is dropping slightly, although it still has one of the highest levels in the world. One sign of the times: A major maker of *pastis,* the licorice-flavored aperitif that is virtually a national symbol, has begun to turn out a nonalcoholic version. *Zut, alors!*



Silicon ribbons for solar cells

Engineers at Arthur D. Little, Inc., in Cambridge, Mass., report that they have succeeded in growing large-grain polycrystalline silicon ribbon as wide as four inches with improved handling characteristics, as seen in the photo above. The edge-stabilized ribbon process under development by Arthur D. Little since the beginning of 1980 promises solar-cell wafer material with conversion efficiencies "well above 10 percent," at a cost of as little as 60 cents per peak watt.

Continued



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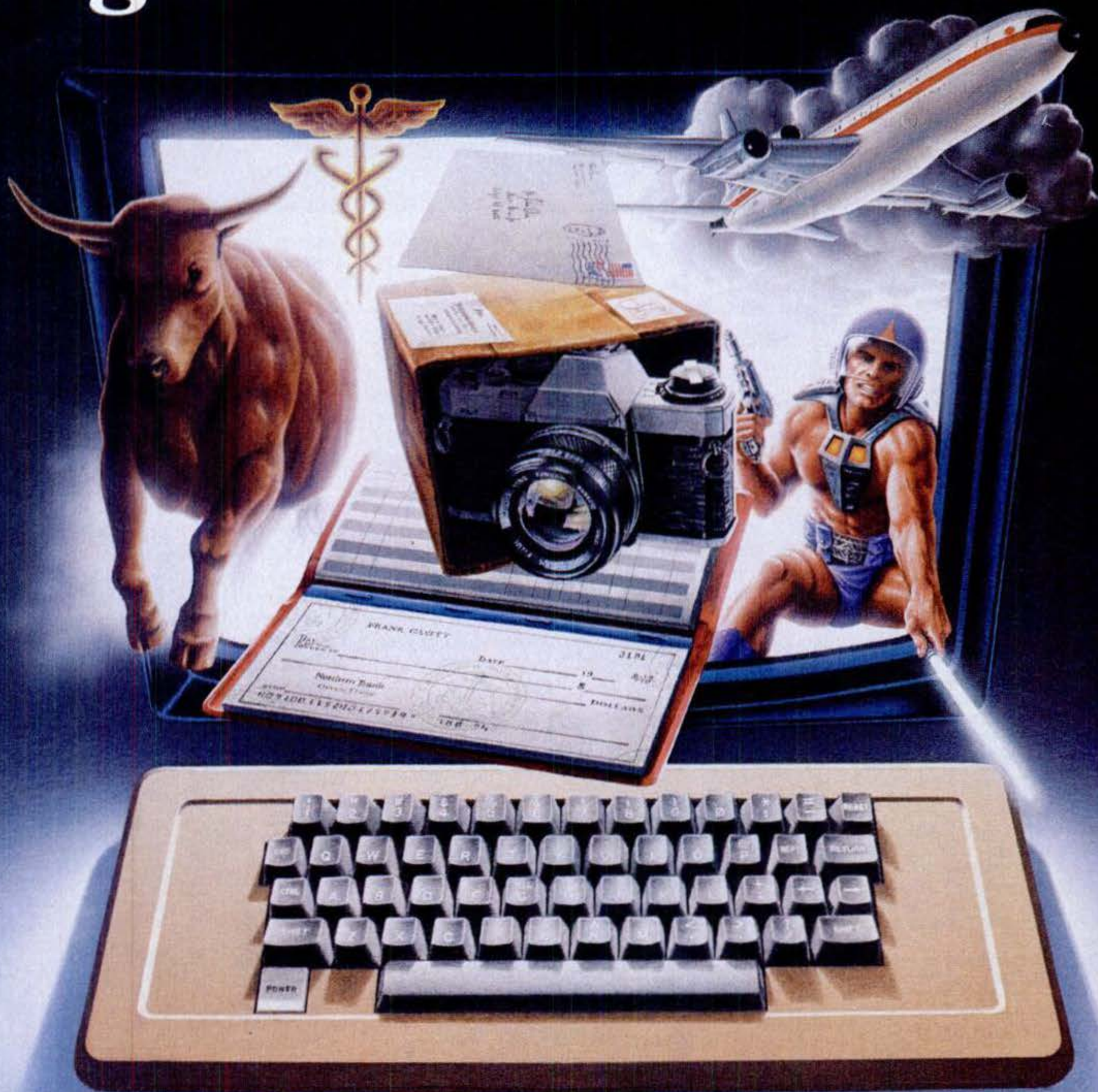

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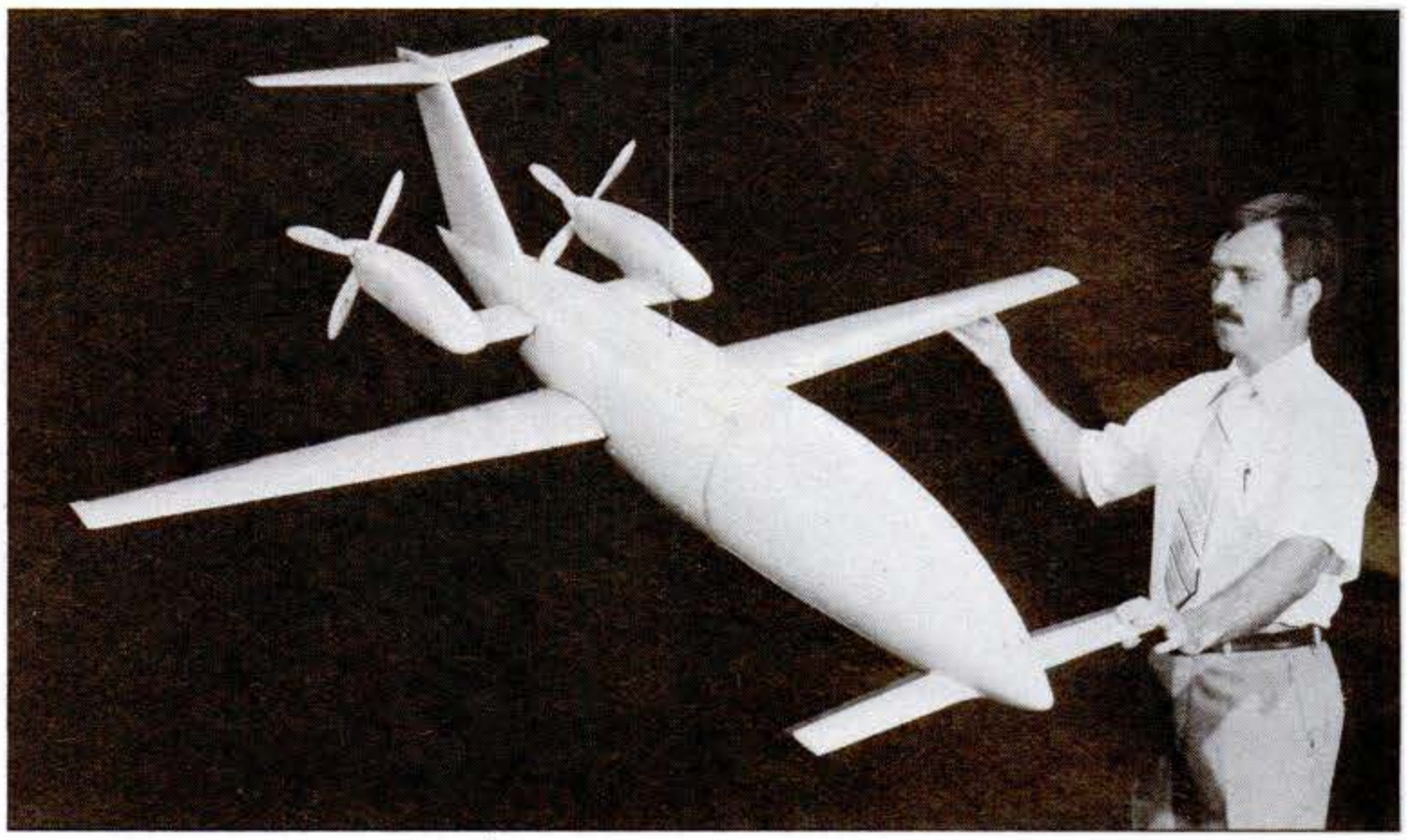


Future commuter

The one-seventh-scale model in the photo above represents NASA's latest thinking about the future of commuter aircraft. The craft is a "three surface" version, so called because it has a forward canard, a main wing, and a rear horizontal tail. It is being tested in a Langley Research Center wind tunnel to investigate stability and control, especially in low-speed situations. One notable feature is that the model can be taken apart and reconfigured by moving the engines and wing to various positions and by removing the canard. The long, slender wing is designed to be fuel-efficient; engines are aft-mounted because they do not interfere with wing lift and generate less cabin noise in that position.

Insulin from bacteria approved

The U.S. Food and Drug Administration has concluded that a form of human insulin manufactured by bacteria through recombinant-DNA, or genetic-engineering, techniques is both safe and effective and may be sold in the United States. The hormone, to be made and marketed by Eli Lilly and Co. under license from Genentech, Inc., was developed by biologists at the City of Hope National Medical Center and Genentech. It is the first human-health-care product from recombinant-DNA technology to be so approved [see "Designer Genes," PS, May '82].

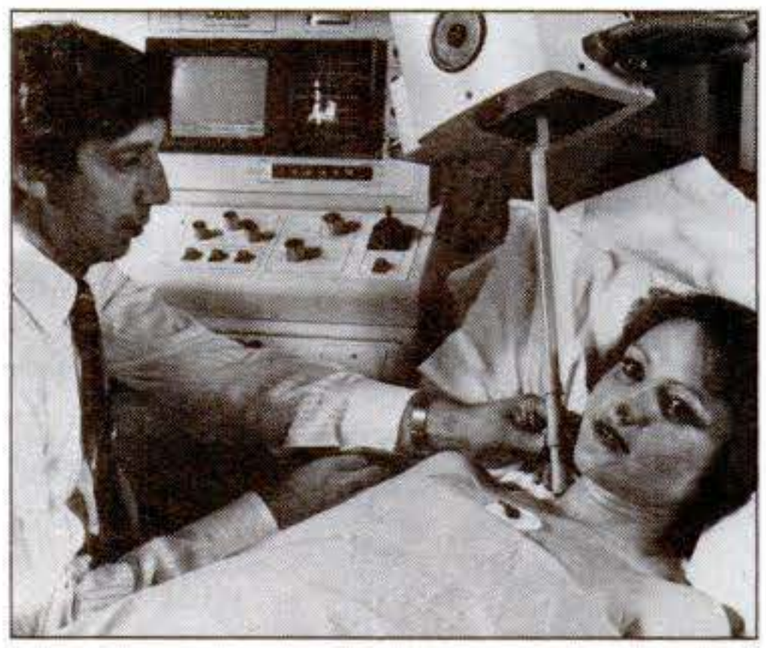
Termites and the atmosphere

Environmental chemists have added termites to the list of principal sources of methane in the atmosphere (the others are swamps, rice paddies, geologic gas reservoirs, agricultural burning, and digestive processes in cows and other ruminants). Patrick Zimmerman of the National Center for Atmospheric Research says that termites, which inhabit two-thirds of the Earth, emit some 165 million tons of methane, about half the annual global production. Termites have an anaerobic digestive system, in which methane, or "marsh gas," is a byproduct. Methane acts much like carbon dioxide to create a greenhouse effect in the atmosphere because it is transparent to ultraviolet radiation but absorbs infrared.

Doppler ultrasound probe

Dubbed MAVIS 200, the computerized blood-flow analyzer seen in the photo below measures circulation in arteries and veins. It produces three-dimensional TV images of the insides of blood vessels and computes not only the total volume of blood flow in a particular artery or vein but also the velocity profile of blood at any selected site in the vessel. Significantly, it does all this without physically invading the circulatory system, thus sparing the patient considerable discomfort.

In use, electrodes are located on the



body to record the heartbeat, and an ultrasound probe is gently moved over the surface of the skin. A beam of ultrasound from the probe's transducer is directed through the skin to a blood vessel and is reflected by the moving blood cells. The motion of the blood cells produces a Doppler shift in the frequency of the ultrasound, which can be detected by standard techniques.

In the photo, the MAVIS 200 is being used to scan one of the carotid arteries. Detecting obstructions there can alert physicians to impending stroke or other severe problems in high-risk patients. PS

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Satellite spots a future supernova

Nine thousand light-years away from Earth, the life of the most massive and luminous star known in the Milky Way is drawing inexorably to a close. Soon—tomorrow or 10,000 years from now—it will become a supernova, producing more light than our entire galaxy. The end will have come for Eta Carinae, 10 times more massive than the sun and yet a mere youngster by comparison, a bare two million years old.

How do we know Eta Carinae is about to blow up? Astronomers Kris Davidson of the University of Minnesota; Nolan R. Walborn of Cerro Tololo Inter-American Observatory in Chili, now at Goddard Space Flight Center; and Theodore Gull, also of Goddard, have been studying the extraordinary star, with support from the National Science Foundation. "Only one star in about 10 billion is as massive as Eta Carinae," reports Dr. Davidson. "It's so powerful, it's really going fast."

One clue to the star's imminent demise has been its variability. Eta Carinae has been observed for about 200 years. At first a "fairly bright" star, during the 1800's it shot out some material and became the second-brightest star in the sky. Later the exploded gas condensed into a cloud, obscuring the star.

Interesting facts, but was the star just forming, an unusual middle-aged star, or one near its end? The key was the cloud's composition. With the help of the International Ultraviolet Explorer satellite [PS, Sept. '78], astronomers were able to determine that the gas was mostly nitrogen, an indication of advanced age. Conclusion: The star is dying.

Once it blows, the Southern Hemisphere star will be visible even in daylight. (It's almost over the Falkland Islands and can be seen from Puerto Rico.) Asked to speculate how bright the supernova might be, Dr. Ted Gull said, "Somewhere between Venus and the moon." The brightest supernova yet recorded was in 1006 and appeared in the constellation Lupus the Wolf. Eyewitness accounts say it was about the brightness of a half-moon.

As Eta Carinae burns its last stores of fuel, we can, for the first time, prepare to see and study one of the most spectacular events the universe has to offer.—*Kathleen Brown*

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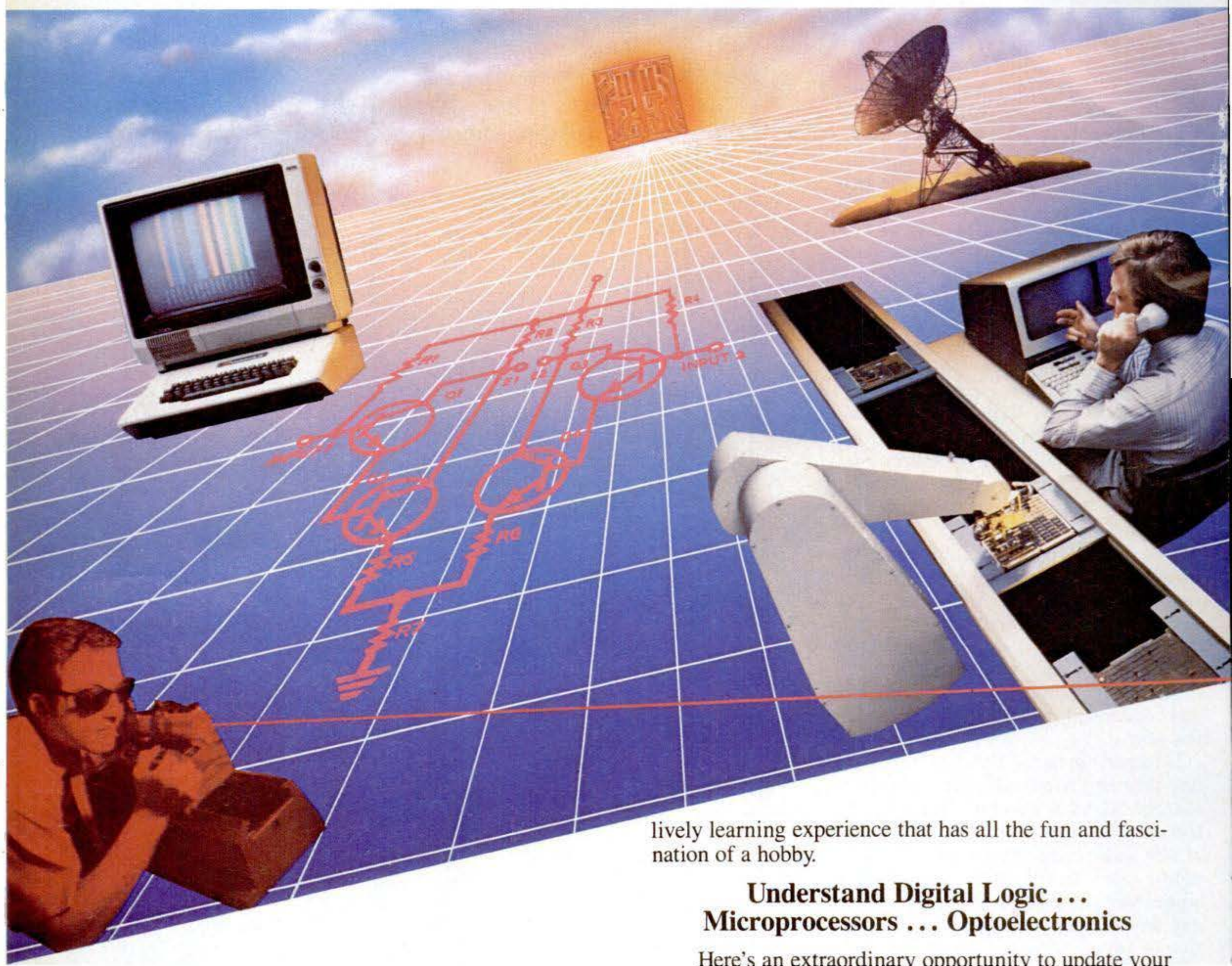

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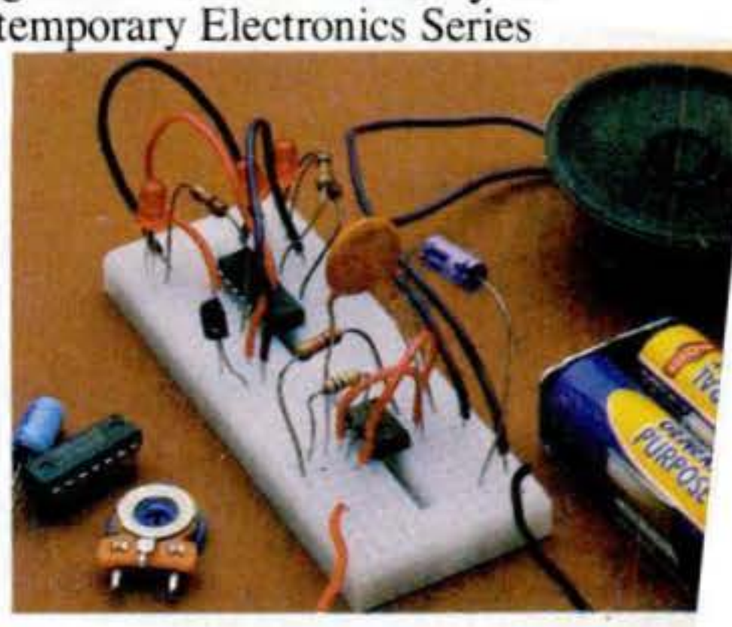

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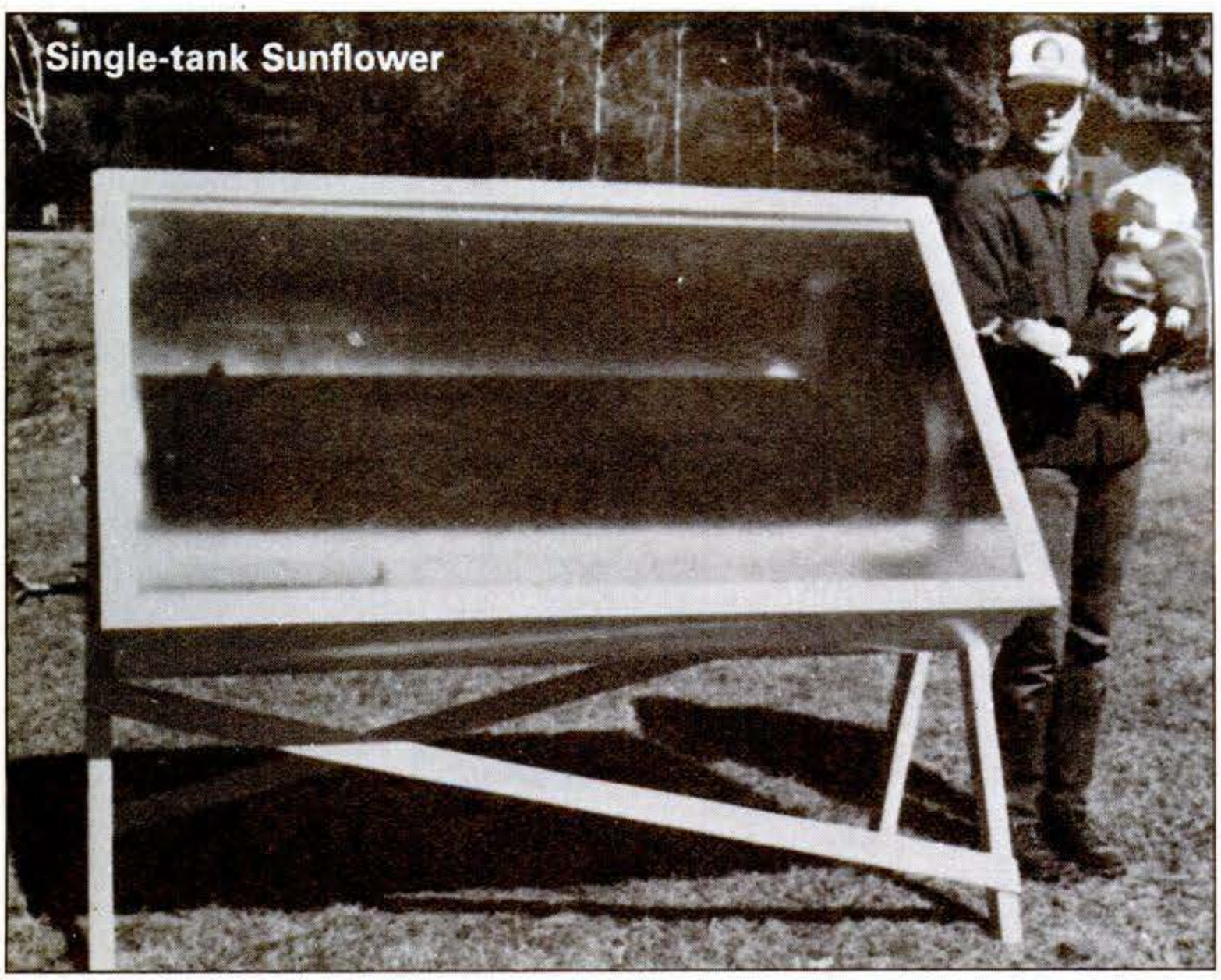
Two batch heaters: dollar-for-dollar solar champions

If simple is beautiful, these units are knockouts

By DANIEL RUBY
ILLUSTRATIONS BY GERHARD RICHTER


Single-tank Sunflower

Double-tank Sun Mummy

With mu things, "cheap and easy" is synonym is with "low quality and expensive n the long run." Happily, with solar ergy this is not always true. In fac it is axiomatic of solar design that e most cost-effective systems are e that operate at low temperatures d supplement a conventional hea source instead of supplying the b load.

Batch heaters heap and easy—nothing more th un-heated, enclosed black tan nnected to a home's water supp before the existing water heat hey use no pumps, heat exchan solar con- trols, or moving par They can supply one-thny kind. of a family's year-rou one-half needs, though they mat-water shut down during the co to be to prevent freezing. nonths

This month, we presen ader- designed batch heaters: son's Sunflower and Alb hn- Sun Mummy. Either can b es's weekend's time using loc n a able materials costing ab il- Though they have much in the details of the two unit interesting contrast in choic rials and design priorities.

The Sun Mummy uses tv Its enclosure, including an cover, is insulated. It uses glazing and plumbing conn is designed to operate at up grees F and to save some he overnight. The Sunflower, er hand, has one tank, an u enclosure, special solar-ty and garden-hose hookups. at only 90 to 110 degrees F water must be used the d duced. Both designers cl 30 percent fuel saving an less than three years.

The Sunflower perfor through use of a cusp ref ing). This concentration oped by French solar pio and Meinel) effectively collector's area and mai ciency as the sun cha during the day. "It is so ficient," Johnson says features of insulati plumbing almost im come cost-ineffective." surprising claim, J that insulated test ve lector produced high

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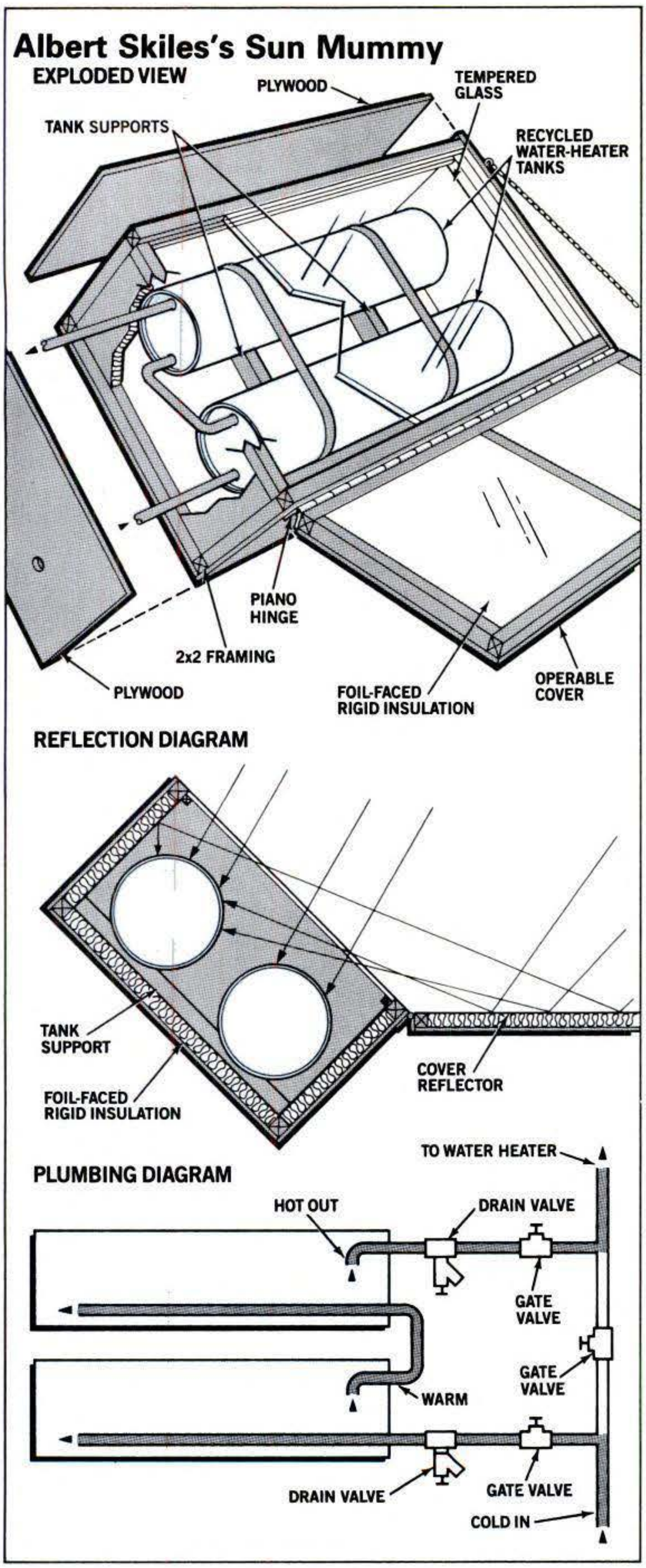

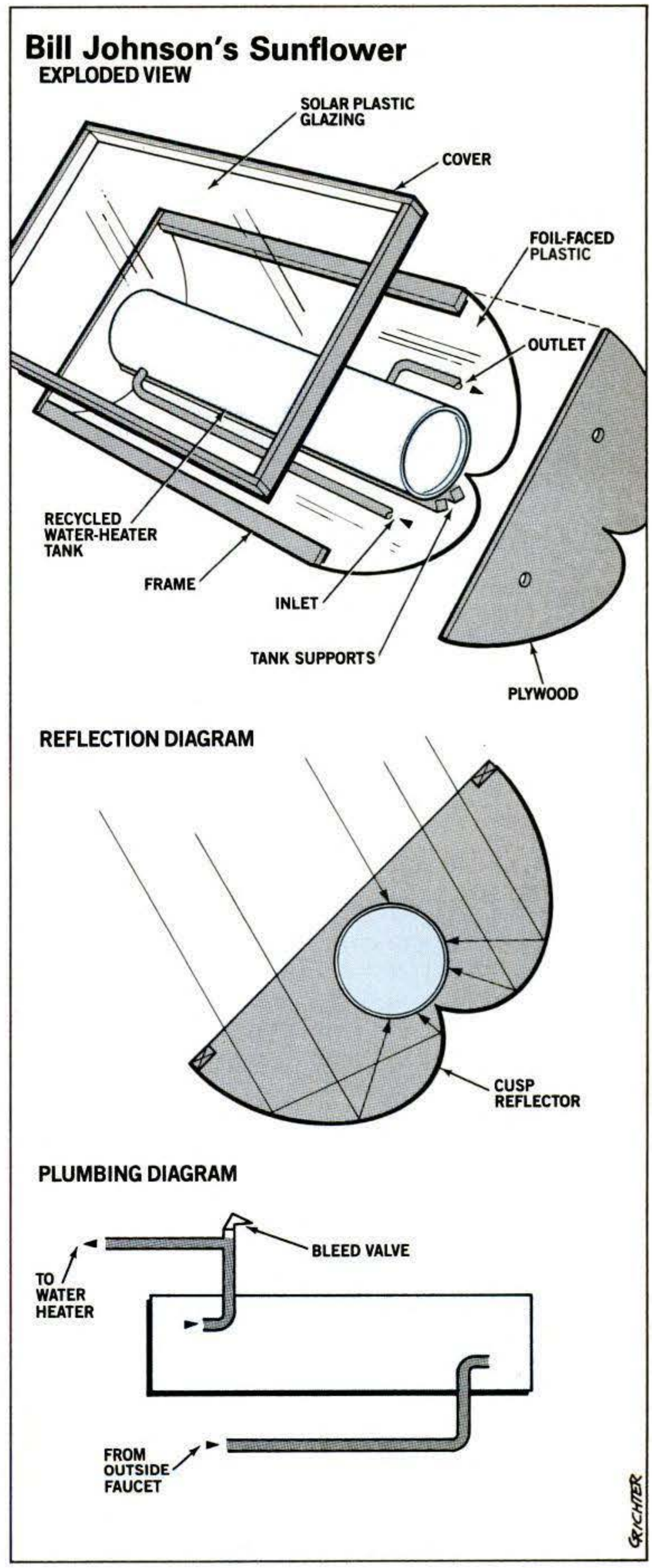

but not enough to overcome the cost saving of an uninsulated box. Nor could the added cost and trouble of using copper tubing be justified.

Skiles's Sun Mummy uses quality insulation and plumbing parts. But the designer shunned special solar glazing in favor of standard 34-by-76-inch tempered glass. "This size panel is kept in stock by almost all glass suppliers as a replacement for sliding glass doors," Skiles says. "It won't deteriorate under sunlight and is resistant to impacts."

The size of the panel dictated other design decisions: the size of the enclosure and the use of two tanks. Like the Sunflower, the Sun Mummy's enclosure is lined with reflecting foil—but not in a cusp shape. To increase collecting area, the Sun Mummy's open cover focuses additional solar energy on the tanks. Skiles plumbs the two tanks in series to provide hotter water. A greater quantity of cooler water would result from connecting the tanks in parallel.

Sun Mummy plans are available for $8 from Solar Design (230 W. Center, Fayetteville, Ark. 72701); Sunflower plans ($10) or kits ($186), from Johnson Solar Designs (RFD #1, Old Rte. 114, Goffstown, N.H. 03045). PS

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Physicists seek first atoms created by Big Bang

How do you go about sniffing out a single atom—an object so small that 100 million of them in a row would measure only an inch long? To thicken the plot, consider that out of every trillion atoms, only one may be of the variety you're seeking. Indeed, the atom may not exist at all.

But physicists at the University of Minnesota are betting it does exist. And to find it, they've developed a technique called laser fluorescence, which permits the detection of single atoms as they pass through a laser beam. "Still, the search will make looking for a needle in a haystack seem easy," says George Greenlees, the project leader and a professor of physics in the University's Institute of Technology.

The atoms the physicists are seeking may have been formed in the first few microseconds after the Big Bang, the explosion of energy that many scientists believe created the universe 20 billion years ago. If so, they would be very heavy atoms. The reason: Immediately after the blast, temperatures soared to maybe one billion trillion trillion degrees C; however, expansion and cooling took place rapidly. "The result," Prof. Greenlees theorizes, "may have been that very heavy quarks [hypothetical subatomic particles] were created and trapped in the nuclei of those first relatively few atoms." Thus those isotopes would be 100 to 10,000 times heavier than others formed a few seconds later when the temperatures were already significantly lower. Most of the universe is composed of these later, lighter atoms.

But if some of the early, heavy isotopes survived, they should be distributed randomly throughout the universe, Greenlees believes. To detect them, his team built a large table and suspended it so carefully that it doesn't move—not a millimeter—even if a lab door is slammed. The laser was set up using lenses and mirrors arrayed on the table like croquet wickets. They tuned it to such a precise frequency that it varies no more than one part per billion.

At the other end of the table is an oven. In it the physicists will heat sodium, the material they chose for the test. "We could use any material," says Greenlees, "since evidence of the Big Bang—if it is anywhere—should be everywhere." A pump will maintain a constant vacuum within the apparatus. Finally, they hooked up a computer and fine-tuned the entire setup to eliminate distortion from extraneous events.

When everything is go, the researchers will vaporize the sodium in the oven, send it into the vacuum chamber, and expose it to the laser beam. A sensitive detector will measure each atom, looking for any that is much heavier than the rest.

Greenlees hopes to find some heavy isotopes, of course, but even a negative result would be useful, he maintains, for it would tell us what did *not* occur during the Big Bang, or, at least, that the particles created were not as stable as predicted.—*V. E. Smay*

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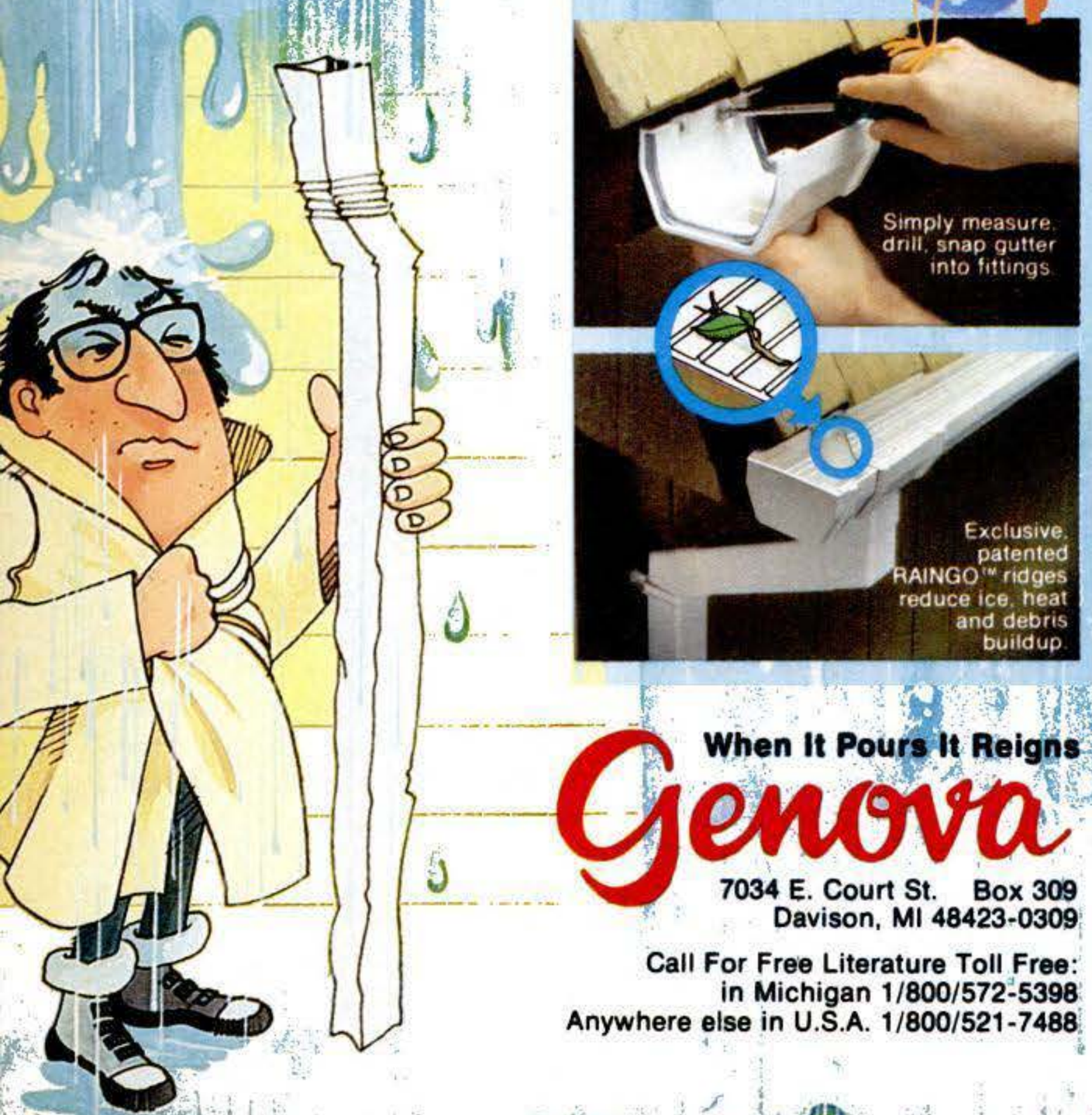

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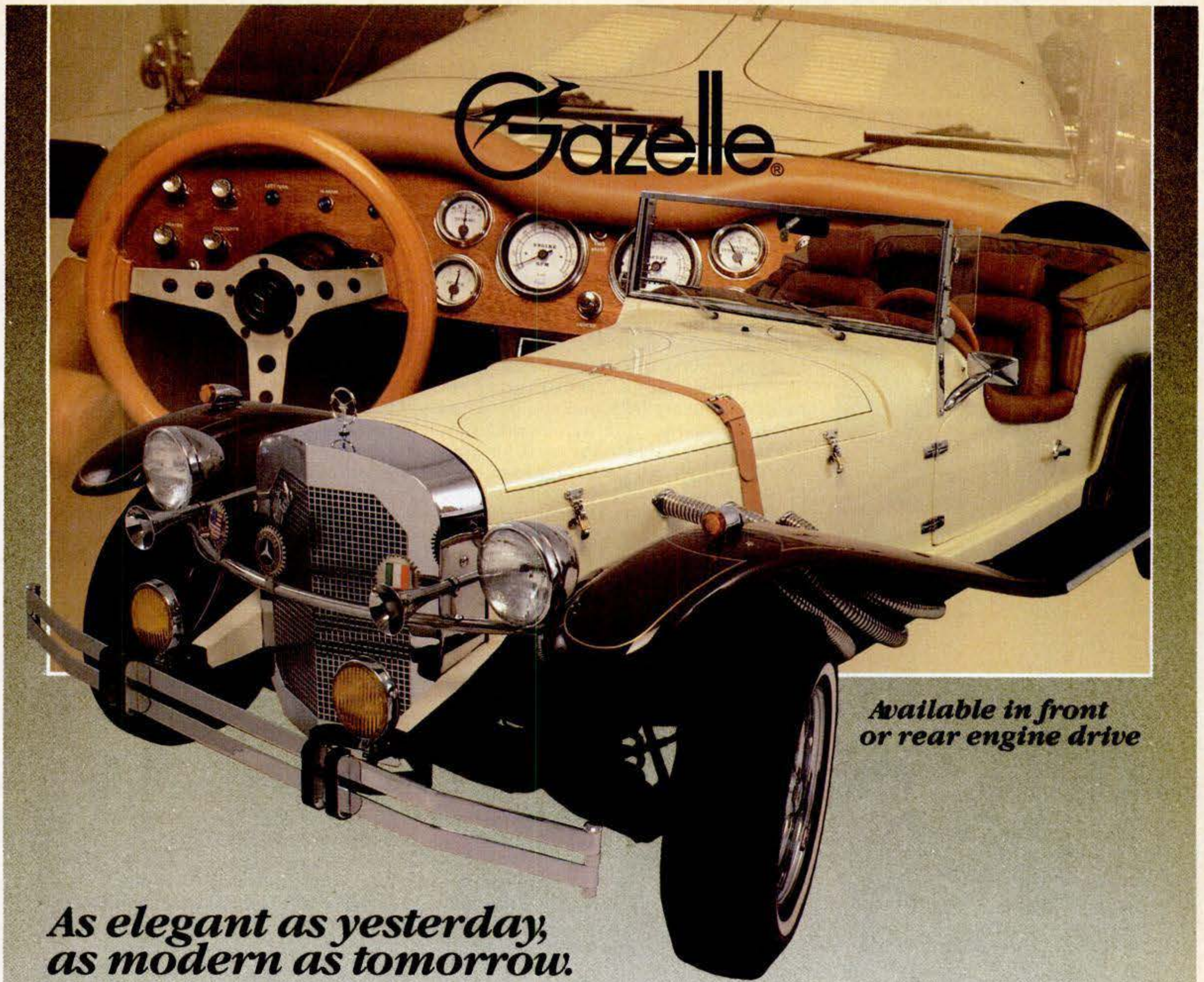

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THROUGH THE VIEWFINDER

By EVERETT H. ORTNER

Kodak plays a neg

A darkened room. A 21-inch TV screen. A dozen or so feet away, a small box on a table. Next to that, a young woman with a small remote-control device in her hand. These were the elements of a recent Kodak demonstration before a small group of reporters in Cologne, West Germany.

As we watched, she inserted a Kodak film disc in the unit on the table and flicked a switch. An image appeared on the TV screen in handsome color. It was the positive image of the film negative.

Thus did Kodak bring together the worlds of film and video technology. This experimental video-display unit, built in Kodak's research labs, could provide a link between the snap-shooter's picture taking and his TV watching at home. The system would enable the disc-camera user to see his pictures much as transparency shooters do—projected large.

Indeed, the disc-camera photographer would have a further advantage: the chance to manipulate the film image. Using the remote control, our Kodak demonstrator was able to zoom in for a close look at as little as a quarter of the image, or move to either side. More: As she did so, she was encoding the disc's magnetic core for future viewing. Thereafter, every time she returned to that picture, the screen showed the cropped image. And even more than that: If she wanted prints made from that negative, the encoding would instruct the processing machinery to make the print exactly as she had cropped it.

At the heart of Kodak's system is a CCD—charge-coupled device—a solid-state imaging sensor that converts film images into electronic signals. These signals—inverted to change the negative image to a positive one, color corrected, enhanced for sharpness, and compensated for compatibility with video—would be delivered to the antenna terminals of your TV set. The picture on your screen, says Kodak, would have more than 350,000 pixels—picture elements—for a very detailed TV image.

Although the system is designed for disc-camera users, it seems obvious that the technology could be expanded to other areas of photography. A 35-mm photographer, for example, might view his negs on TV, just as if he were looking at a slide show; and, if there were a magnetic stripe on the film, he could at the same time encode each frame both for future viewing and for print making. Indeed, instead of routinely ordering a print from each negative as he now does, he might view and crop the negs electronically before selecting those to be printed.

Is such a system in sight at this time? Kodak says it's not committed to manufacturing a disc player yet, but it's "one of many new product possibilities that make the future look so exciting."

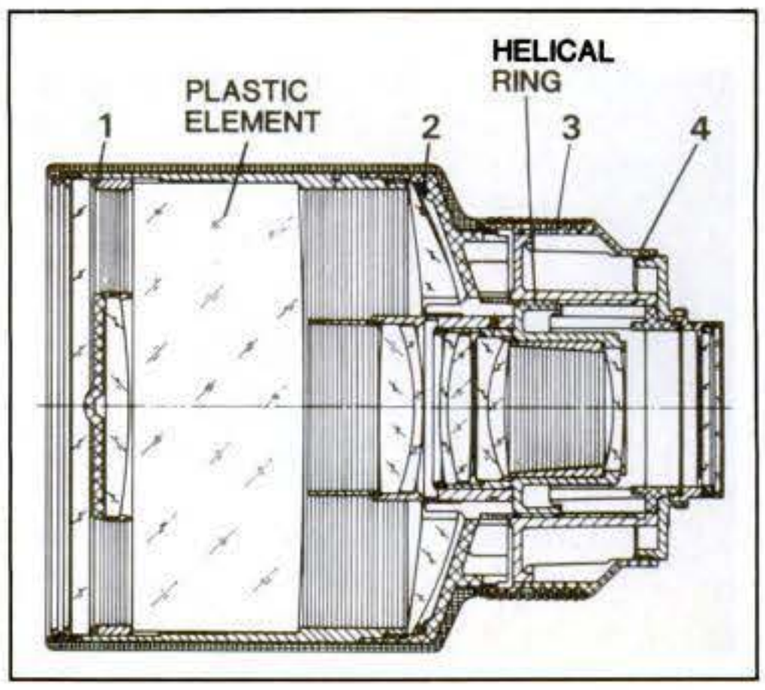
Kodak bats 1000

And more Kodak news: At Cologne, the company introduced a new Kodacolor film with an ASA of 1000. It's based on a new silver halide technology that, says Kodak Research Director L. J. Thomas, "could be the key to even more-efficient films from Kodak." We tried a sample cartridge at POPULAR SCIENCE and liked the results: excellent color and sharpness, slight graininess.

Revolutionary hybrid: 450-mm cat with a plastic element

Here at POPULAR SCIENCE we have been tracking the course of a lens revolution exemplified in Vivitar's Series 1 f/4.5 450-mm catadioptric lens, which should be on the market this spring. In December '81 ["Now They're Designing the Next Generation of Superlenses"] we described the importance of plastics in overcoming the difficulties of making aspheric lens elements. Traditionally ground lenses, made by passing an abrasive material over glass in a spherical arc, suffer from spherical aberration: Light rays passing through in any place but the center come to a focus at a point nearer the lens than on-center rays. Costly extra elements are needed to correct the resulting lack of sharpness. Aspheric lenses eliminate that need. But they have been prohibitively expensive—in glass.

Now I have been able to examine a prototype of Vivitar's new hybrid—glass and plastic—lens. At its center is a molded aspheric methyl methacrylate element three inches across and an inch thick. The plastic element contributes not only to the lens's lightness (2.6 pounds) but also to its f/4.5 speed. You focus the lens by means of an internal rear group of elements. An outer ring moves a helical focusing ring inside. Further protection for the internal lens parts is afforded by four sealing rings (see drawing), designed to make the lens airtight. For still more protection, the barrel is encased in a thin rubber jacket. The lens comes with five rear-mounted screw-in filters (red, yellow, skylight, and two neutral density). Price: probably (my guess) $250 to $300. I'll report further on this unique lens when I get hold of one. PS



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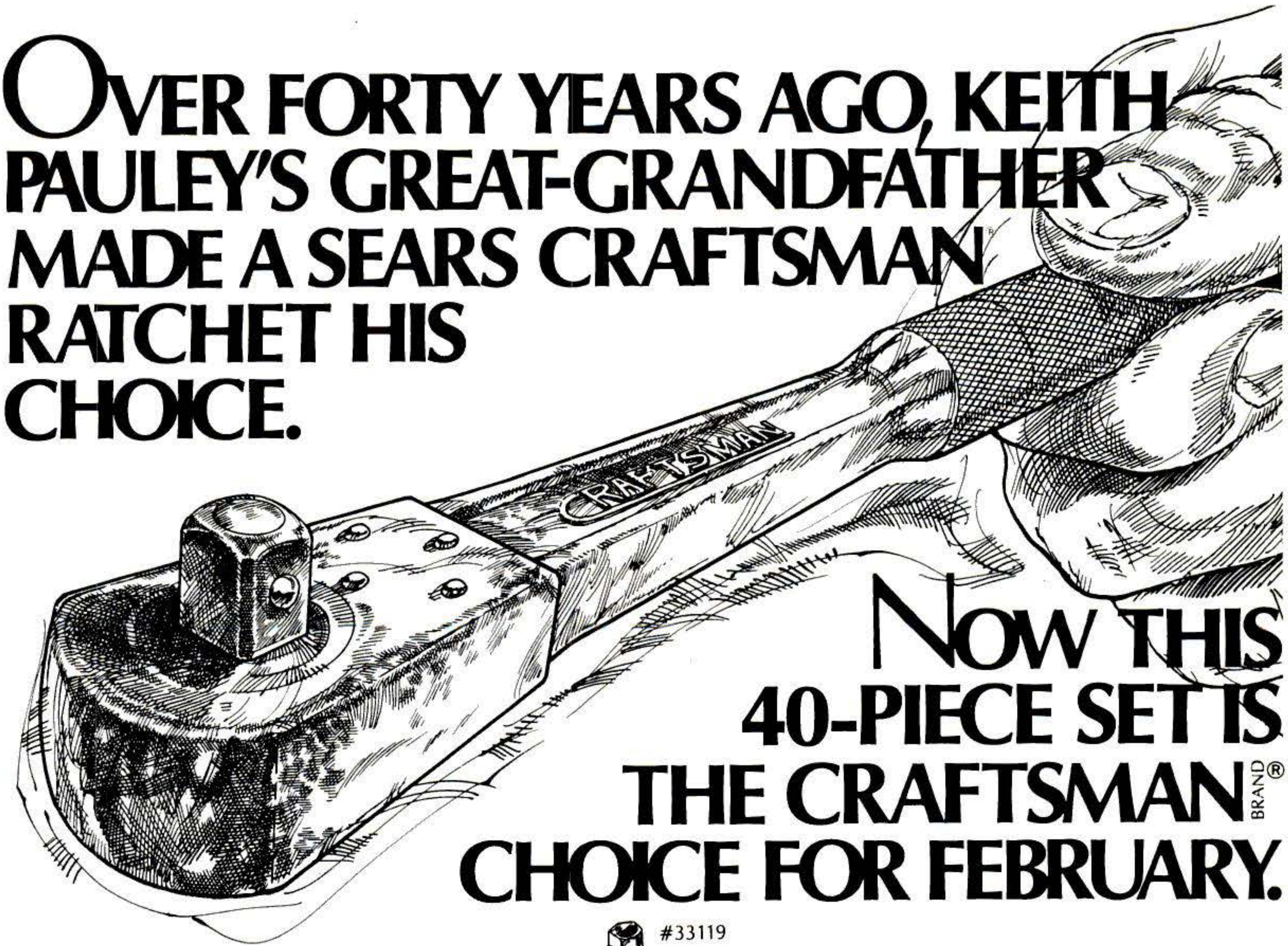

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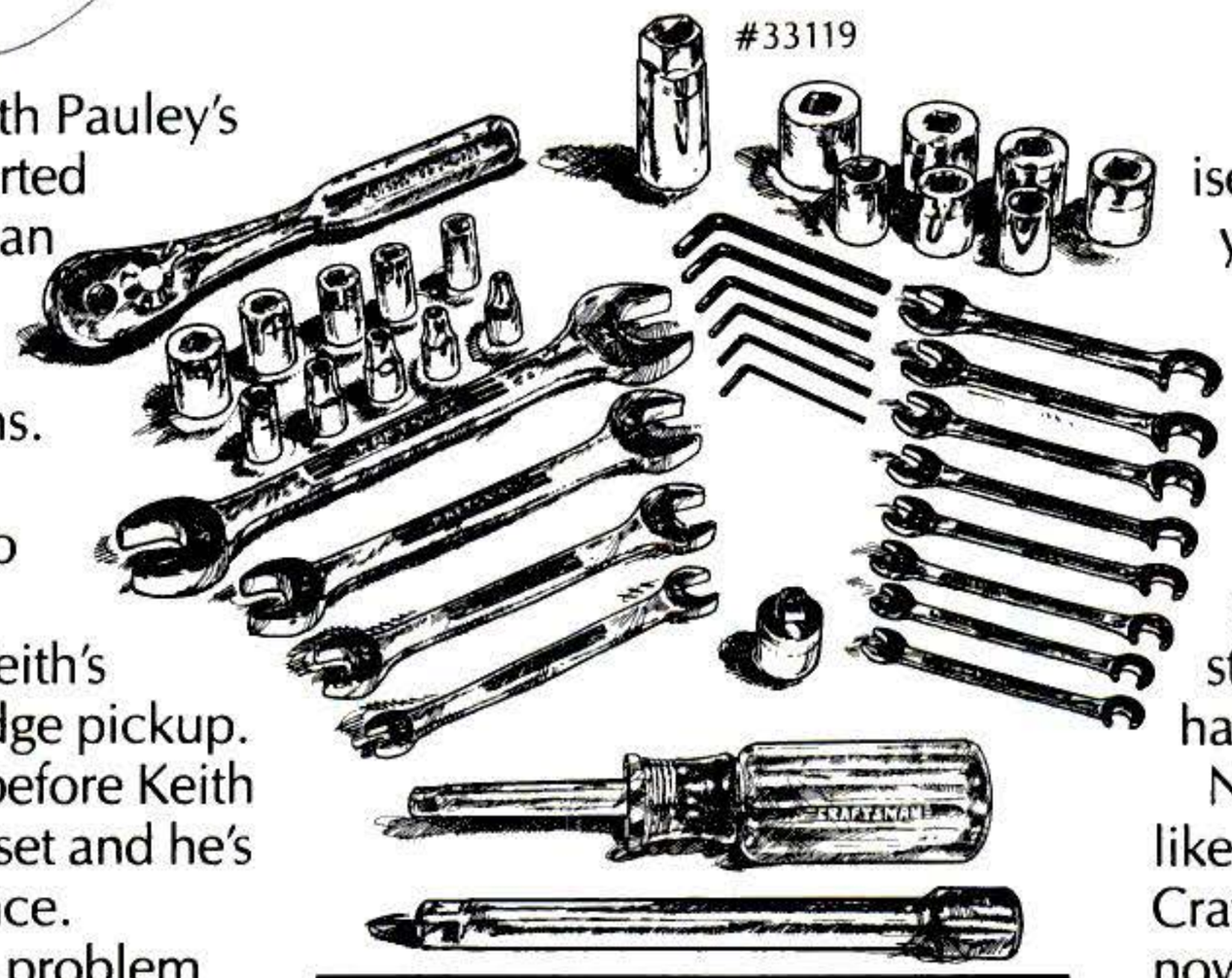

Back in the '30's, Keith Pauley's great-grandfather started out using his Craftsman mechanics tools on his horsedrawn hay rakes and wagons. The set was handed down to his son, who used it on all sorts of things. Then came Keith's Dad and the '36 Dodge pickup. Well, it wasn't long before Keith got his hands on the set and he's been using it ever since.

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HOUSEPOWER CLINIC

By EVAN POWELL

Energy-Saving House lives on

One of the big successes of the 1982 World's Fair in Knoxville was the Energy-Saving House. For those of you who didn't visit, the house was a turn-of-the-century preservation on the fairgrounds that was retrofitted with energy-saving devices—ranging from greenhouses to vapor-compression cooling units. It also contained displays of other kinds of equipment, most of which, I'd say, would work well. All in all, the house stimulated a lot of positive thinking from both visitors and exhibitors, and already Conergy Marketing, host of the house, is at work on its next version—for the 1984 World's Fair in New Orleans. According to Conergy's Larry Heard, the new version will be a modern home, possibly a panelized structure like our PS research home here on Chestnut Mountain, designed to illustrate the potential of energy-saving equipment in current home designs. In the meantime, Conergy is publishing a newsletter about energy-saving devices. To subscribe, write Energy-Saving House Letter, Box 30073, Knoxville, Tenn. 37930, or call toll-free (800) 282-7516.

Q&A Battery-powered log splitter

I read about the Yukon electric log splitter in the June 1981 issue of PS, but have not been able to find one locally. Is the splitter still available, and if so, where can I find one?

B. J. Lewis, Asheville, N.C.

The Yukon log splitters have been scarce, but the X-1000 is now in full production and you should be able to find one at a local fireplace or wood-stove dealer by the time you read this. If not, write Yukon Energy Corp., 9890 N.E. Highway 85, Minneapolis, Minn. 55434. They'll put you in touch with the nearest dealer.

115-volt thermostats

My radiant-heating system, installed in 1959, is controlled by a General Controls thermostat that operates on 115 volts. I want to change to a modern thermostat with more flexibility, but those I find operate only on 24 volts. How do I convert my system so it will operate with a 24-volt thermostat?

M. Weissbluth, Stanford, Calif.

You need to add both a transformer and a 24-volt relay—the transformer to power the thermostat (which in turn would energize the relay upon demand for heat) and the relay to control the burner and pump. A simpler solution would be to use an energy-saving thermostat such as the light-sensing Li/Tronic [PS, Nov. '81], which operates on 115 volts and could replace your old unit directly.

Keeping cool

My older Kelvinator 766-IR refrigerator-freezer, which has automatic defrost in the refrigerator section only, doesn't keep food cold enough (around 45 degrees F). After I discovered that (by monitoring the temperature with an accurate thermometer), I replaced the thermostat. The refrigerator operated satisfactorily for a day or so, but then the trouble recurred. There doesn't appear to be a defrost timer in the circuit. What else can I check?

Bill Santarsiero, Waterbury, Conn.

Like most auto-defrost systems, yours is a cycle-defrost model controlled by the thermostat in the refrigerator compartment. After it shuts the compressor off at the end of the cycle, it lets the temperature on the chilled evaporator plate rise above freezing (usually to about 39 degrees F) before it allows the system to run again. Knowing that, you can begin to search for the real culprit.

First check the freezer-compartment temperature. If it's very cold (below zero degrees), you have big problems—probably a slow leak in the system that prevents the evaporator plate in the refrigerator section from cooling even if the system runs all the time. This is a job for a professional with special equipment.

If the freezer temperature is normal (zero to 15 degrees) or if it's slightly warm, the problem may be no more than a lint-clogged condenser that prevents the system from operating at full capacity.

Insulating water heaters

For 10 years I've kept records on energy use in my small business. I use one or two gallons of hot water per day in the summer. With all gas turned off except to the hot-water tank, I use six to seven ccf [600–700 cubic feet] of gas per month, usually within the minimum amount charged by the gas company. The water heater is 13 years old and only holds 20 gallons. It was the cheapest heater to buy at the time. What about insulation? I think it's pretty rare for a heater to require additional insulation.

E. M. Pinkerton, Elmwood, Neb.

Not so rare. But there are variables, and it's wise to consider them. One variable is the location of the heater. If the heat radiated from the water heater is transferred into an area where it's needed, that's not a loss. On the other hand, if the heater is located in a cold area, it is a loss, one that would be greater in winter than in summer. Another factor is the size and construction of the heater. Yours, being small, would have a much lower heat loss than an 80-gallon model, and even 13 years ago some were better insulated than others. You may be one of the lucky ones.

Some good studies support the evidence that many heaters can benefit from added insulation. My own feeling is that if the heater cabinet feels warm to the touch, it could use a blanket.

A word of caution to those considering such blankets: Be sure to follow instructions for cutting insulation away over electrical access panels, around openings for air flow, and over vents in gas-fired heaters.

Bridging the gap

I removed the top of my Maytag A206 washer when I noticed water leaking on the floor, and found that the source was a plastic gadget located in the hose line between the inlet valve and the tub. I removed the part and cleaned it, but it still leaked. I then spliced the two ends of the hose together with a short piece of copper tubing, and the machine now runs fine again. What's the plastic gadget for and should I replace it?

Phil Silverman, Petersburg, Va.

That plastic part is known as a siphon gap or air gap and is required on all equipment connected directly to a water line. Its purpose is to prevent siphoning of contaminated water into your water-supply line in the event of a pressure drop while the machine is in operation. Replace it right away.

Spring cleaning

My sister gave me a little-used refrigerator that had been in storage for two years. When I opened the door I discovered that its food compartment was full of mold and mildew. I've cleaned and scrubbed for two weeks now. It looks better, but it still has an odor. Is there any cure?

Deborah Smith, San Francisco, Calif.

Go over everything once more, using a solution of baking soda and water. It helps to run the refrigerator because the air circulation and cooling will rid it of any moisture that may remain. Buy at least two activated-charcoal filters from a department or appliance store and place one in the freezer and the other in the refrigerator compartment. The condition should gradually improve. To prevent such problems whenever a refrigerator is turned off for more than 24 hours, the doors should be blocked open with cardboard or wood.

Got a home-equipment problem? Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

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Let the old dog lie

Several ads on TV urge viewers to get their transmission oil changed, but I seem to remember that you said if the transmission is not giving any trouble, it's best not to open it up. Am I right?

Robert Overfelt, Terre Haute, Ind.

Yes, but I think if you get two to three years of good service from a vehicle in heavy use, it's not a bad idea to change the oil. I believe in that case, a change once a year or 20,000 miles will probably pay off. My leave-the-old-dog-alone-as-long-as-it-is-working theory is a different deal. If it's not necessary, I'm afraid disturbing the old stuff with new lube might cut loose the residue.

Carb-kit kickback

I recently installed new plugs, wires, rotor arm and cap, and a carburetor tuneup kit in my 1972 Ford wagon. Now it coughs and sputters at around 30 mph when I attempt to accelerate fast. If I accelerate gradually, it runs okay until it reaches 50 to 55 mph, where it hesitates. What do you advise?

Bill Palfreman, Dearborn, Mich.

Go back into the carburetor and find out why the acceleration system isn't working. Be sure ignition advance is right. A weak coil can also do it.

Pinging problems

My 1976 Buick Century with 231-cu.-in. V6 has had a pinging problem since day one. I solved it for about 70,000 miles with Amoco premium unleaded gas. Now the pinging has returned. The timing has been adjusted by many different mechanics to no avail.

Robert Kalin, Miami, Fla.

Pull the heads and clean off the carbon, and maybe check the valves while you're at it. Then have the distributor centrifugal advance slowed down and get the vacuum advance speeded up. You'll probably get rid of the ping.

Oil use: almost nil

I've been using Mobil 1 in my 1979 Toyota Corolla and '80 Toyota Sport pickup 4×4. I've gone 15,000 miles and not used more than ½ quart of oil in either vehicle. I also have an oil analysis run about every 3,000 miles, and it usually shows normal to below-normal wear. Occasionally, though, an abnormal reading shows up, but then all is okay on my next check. Why? Also, I'm concerned because the viscosity shows up at about 14. Can that protect my car and truck?

Kenneth A. Klem, Deer Park, N.Y.

Your results are spectacular; your oil consumption is the best I've ever heard of. Don't worry about viscosity; it's no factor as long as you're not finding wear residue in the oil. The reason why wear samples rise and fall is that sometimes material held in an area falls back into the system because of its weight or because of an oil-flow change during an extra-hard run.

Popped plug

A small plug on the carburetor of my 1979 Lincoln Mark III popped out; a mechanic tapped it back in with a hammer and sealed it with epoxy. Is this safe? What's the purpose of the plug?

Pat Sweeney, Roseville, Calif.

I think it's okay. Those plugs seal holes used in manufacturing to permit drilling interconnecting passages. You shouldn't need epoxy if you install a new plug.

Needs head jacked up

My 1980 Omega four-cylinder makes a loud tapping noise until it warms up. The factory rep had a can of engine cleaner poured in, but it worked for only three weeks. A GM service bulletin says a shim and gasket will raise the head and cure the problem. Is that true?

Richard A. Mellwig, Tatamy, Pa.

The bulletin's advice should solve your problem. The necessary clearance has been known for about 60 years. How do cars get built with mistakes in kindergarten engineering?

Bad vibes from engine

My 1976 Dodge van with a 318-cu.-in. engine has a bad vibration at 35 mph. It will also shake when stopped if I speed the engine up to the equivalent of 35 mph.

Lester S. Stahon, Edison, N.J.

Your vibration is in the engine. Look for a loose front balancer, foreign material such as mud or asphalt, or a loose or out-of-balance flywheel. Also check for broken or loose motor mounts. The fan or alternator or their belts could be loose or bad. Least probable—an out-of-balance engine crankshaft.

Leaky cooling system

I have a 1978 Buick Le Sabre, and recently I've had to add antifreeze and water to the reservoir. I don't see anything in the oil,

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and I changed the pressure cap. The dealer did a pressure check and found nothing wrong.

Robert Sanshuk, Chicago, Ill.

You've got a leak. As a rule it's the pressure cap, but it can be a hose that leaks when hot and under pressure. Also, it could be more serious, such as a minor head-gasket leak. Have the dealer fix it before it costs you.

Cadillac 8-6-4 fluctuates

My 1981 V8-6-4 Cadillac vibrates and labors going from four to six cylinders until it shifts to eight or downshifts to four, which smooths it out. I don't understand why it does this on six cylinders. The dealer says it's common on V8-6-4 Caddies. Is this true?

B. L. Jacobsen
South Chatham, Mass.

When everything is perfect and normal, the cars work fine. But when they're off just a little, they can cause mechanics to find another way to make a living. I don't have your answer, and I don't know anyone who does.

Deceleration backfire

After a recent carburetor overhaul my 1975 Honda Civic started "backfiring" through the exhaust. I realize this is not a true backfire but unburned gas exploding in the exhaust on deceleration. What do you think?

Terry E. Cuff, Camden, Tenn.

You have an air leak into the exhaust system during deceleration. Look in the carburetor-heat area since it started with carburetor removal.

Gear grinder

My 1972 Toyota Carina with 120,000 miles drives great, but recently I started hearing a grinding noise that occurs just momentarily while driving. It sounds as if the starter is engaging. I discovered that moving the shift lever forward just a fraction causes it. In addition to other things, I've rigged a wire to hold the lever in place and haven't heard that grind. Why is this happening?

Milton Silver, Van Nuys, Calif.

I'd check the starter solenoid for correct retraction and possibility of input current other than from the key. Then check crankshaft end play and flywheel for tightness. Also, check the transmission for tightness. The trouble may be in the transmission—main drive gear floating, rear main shaft floating, or shift detent in trouble and gears only partially engaged.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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has a fatter sweet spot

In the past, tennis-racket design has been dictated partly by fashion, partly by materials, partly by superstition, but almost never according to principles of physics. So says Enoch Durbin, professor of aerospace sciences at Princeton University. One result: a severe case of tennis elbow in Prof. Durbin's playing arm.

So Durbin invented a racket whose center of percussion ("sweet spot") is at the center of the strings instead of its usual location near the throat. Besides putting the sweet spot where most players meet the ball, this diminishes the vibration-causing "dead" area at the racket's end.

Other designers have tried moving the sweet spot, but always by adding weights to the racket head. Instead, Durbin reduced weight in the throat by eliminating the crosspiece that ordinarily separates the handle from the head. To compensate for reduced stiffness in the throat, the main strings are strung tighter than the cross strings. The mid-size Durbin racket is available in aluminum ($80) or graphite ($200) at most sports shops or from its manufacturer, Princeton Sports Products (Box 648, Exeter, N.H. 03833).—*Daniel Ruby*

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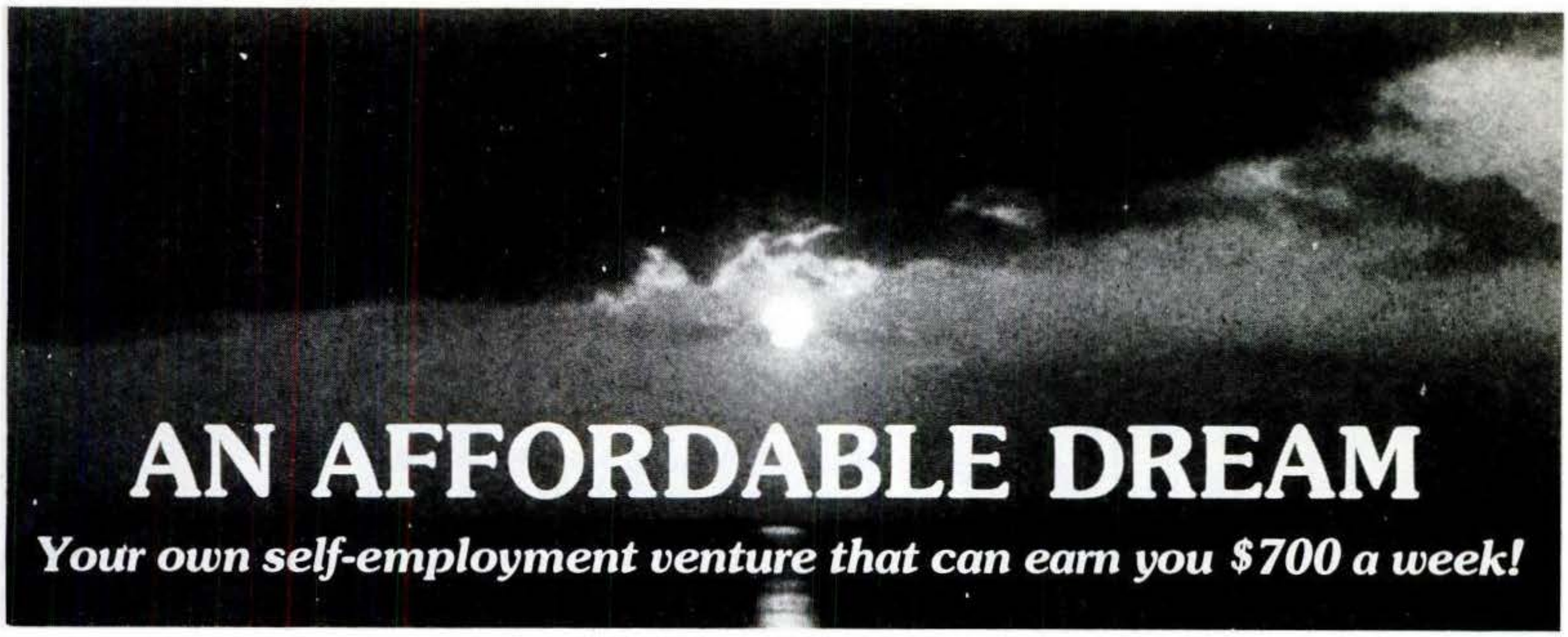

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How much money?

Recently I telephoned some of the people we helped get started in the chimney cleaning business. I wanted to find out — first hand — just how well they were doing. With their permission, I recorded our conversations. We then had a record made which you can play on your record player when you receive our information. Here's what a couple of them said . . .

Dave Richison, Ohio
"The 3rd quarter of this year I did $23,000, the 4th quarter I did $24,000. We should hit somewhere between 55 and 60 thousand this year."

Fran Watts, Virginia
"If we need $200 at the end of the week, it's simply a matter of making a couple of phone calls. The repeats are just fantastic!"

John Moszulski, Canada
"Last month I worked 18 days, and I made 2,600 bucks."

Ed & Mo Simonson, Texas
"We're very pleased with it. We're making a dream come true. We've always wanted some land and thanks to chimney sweeping we now own 30 acres."

"In October of '78 we made $1,530. That was our first October. OK, now in October of '79, which was last year, we made $3,245. Now in October of '80 we grossed $6,593. In one month. We're making two grand a week."

Just what do these people do to earn that kind of money? Sweep chimneys. Six to eight a day if they're fulltime. Two or three an evening plus ten to sixteen on the weekends in the case of part-timers who keep their present jobs. Since the average charge is $45 for the first and $35 for each additional in the same house, it's easy to see how Ed and his wife Mo are making two grand a week.

But Why?

Why would anyone pay $45 to have his or her chimney cleaned? That can be answered in one word — SAFETY!

When solid fuels such as coal and wood are burned in a fireplace or woodstove, they give off a flammable by-product called soot. What is soot? Soot is a combination of fly ash and creosote. Creosote is the flammable unburned residue left over when wood doesn't burn completely. The creosote combines with the fly ash and the smoke carries it into the chimney flue. This soot then sticks to the flue. When a quarter inch or more of this stuff builds up on the chimney walls, it can cause a dangerous chimney fire.

A Chimney Fire

Imagine this tall stack coated inside with a quarter or half inch of flammable soot. When the right amount of heat and oxygen get this stuff burning, you have yourself a real fireworks show. As the creosote burns, the heat causes the natural draft of the chimney to increase ten fold. What you now have is a blast furnace that looks and sounds like a rocket taking off. The temperature of the chimney fire, 2000-3000 degrees, is enough to disintegrate the mortar holding the chimney together. The flaming balls of soot shooting out the chimney's top can land on the roof and the dry leaves surrounding the house. Needless to say — this situation is undesirable and the people who've lived through it get their chimneys cleaned regularly.

According to the National Fire Commission there were 60,000 chimney fires in the U.S. in 1980 causing $300,000,000 of damage. 75% of all fatal residential fires in Vermont, for instance, were caused by faulty installation and maintenance of woodstoves. Tens of millions of people are using wood to supplement the high cost of oil. There are over 40 million woodburning chimneys in the U.S. These people need you to clean their chimneys.

The Height of Technology

How do you clean a chimney? You do it as quickly and efficiently as possible. The more chimneys you can clean in a day the more lives and loss of property you'll save. And how do you do a good job in record time? You use the most advanced system available — The August West System.

One of the key elements in the August West System is the SootSweeper. This machine is a high-powered, high-volume dust collection unit that was designed specifically for cleaning chimneys. When I first started cleaning chimneys I used a large vacuum truck. It worked well, but they cost over $20,000 now. I also had a problem with the 100 feet of hose. It didn't always reach the fireplace from outside. The powerful but portable SootSweeper has the same kind of air-moving muscle as a vacuum truck, but you can bring it right in the house. New filter technology is the key to its efficiency and dependability.

Other key elements of our system are an assortment of high carbon steel brushes, specially designed fiberglass cleaning rods, roof safety equipment, an easy-to-follow handbook with everything from advertising to chimney design, a bi-monthly newsletter, telephone consultation and much, much more. I don't have room to go into all the details right now. Our information kit will explain everything to you.

I'd just like to say that many years and a tremendous amount of devotion have gone into the development of the August West System. We are a strong company with over 5,000 sweeps in our network! You can join us and count on us to help you build a business you can be proud of. We are proud of what we do and the quality of our equipment and service to you reflects our pride.

To sum up, then . . .

Sweeping chimneys may not exactly be a "Lazy man's way to riches" . . . you'll work hard . . . but the pay is exceptional, the demand is steadily growing and new equipment and methods make the job far easier, faster and safer than ever before. Perhaps best of all, this is one of those "dream" businesses that so many of us are always looking for: a business with flexible hours, low overhead and reasonable start up cost, figure about $2500 to do it right.

Find out more about what it's like to be a chimney sweep cleaning 25 chimneys or more a week. Just call **TOLL FREE 800-243-5166** and ask for extension 221. I'll rush you a detailed information kit with the complete August West Story and your 33⅓ RPM record entitled, "Now, Hear It From The Sweeps." We urge you to call us at no obligation, TODAY.

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How science traced the **killer asteroid**

A chance discovery reveals the iridium connection between space and the mass extinctions of life on Earth

By ARTHUR FISHER

The time: 65 million years ago. Earth's poles are ice-free. Over the warm, humid landmasses, lordly dinosaurs roam and feed among small mammals, birds, lizards. Shallow seas harbor fish, giant sea snakes, teeming marine invertebrates.

Suddenly, an object blazes white-hot in the sky as it punches through the atmosphere at a speed of 100,000 kilometers an hour. It is an asteroid, a huge chunk of extraterrestrial rock 10 kilometers across. Its enormous mass slams into Earth like a titanic battering ram, with a force beyond imagining, and blasts out a steaming crater 200 kilometers across. Shock waves rip through the air, violent earthquakes furrow the surface, monster tidal waves roil the seas. The impact throws up a volume of pulverized debris equal to 60 times the mass of the asteroid itself. A vast dust cloud, a thousand times greater than the one Krakatoa was to belch up in 1883, ascends in a dark plume far above the stratosphere. There it spreads in a thick gray cloak until it veils the entire planet from the life-giving rays of the sun.

On Jan. 4, 1980, Nobel laureate Luis Alvarez stunned a crowded roomful of scientists and journalists at a San Francisco meeting of the American Assn. for the Advancement of Science. He and his colleagues had unequivocal, physical proof, he said, that this scenario had unreeled 65 million years ago. Moreover, the evidence showed that the asteroid collision coincided with and probably accounted for the disappearance of the dinosaurs and many other life forms—one of the greatest mass extinctions ever, with 50 to 75 percent of all animal species lost.

At least six times in the last half-billion years of its history, Earth has seen such vanishing acts on a vast scale. To account for them, scientists have proposed supernova explosions, cometary collisions, asteroid impacts, magnetic reversals, Arctic Ocean spillovers, and lunar volcanoes. One English paleontologist dryly suggested that because of a drastic change in the nature of the plants the creatures browsed on, "one is led ineluctably to the conclusion that the poor dinosaurs died of constipation."

But Alvarez's asteroid hypothesis was different from all the preceding ones. He and his colleagues said that 65 million years ago an asteroid had left a chemical calling card—iridium—that was demonstrably not of Earthly origin. "That's what made their theory qualitatively different," said David Raup, a noted paleontologist and expert on mass extinctions who is chairman of the geosciences department at the University of Chicago. "The Alvarez theory is testable."

Three years ago, the original hypothesis and the evidence adduced for it were greeted with skepticism by a substantial slice of the scientific community. Today, although a lively controversy persists over the *biological* scenario Alvarez proposed, so much new evidence has been amassed that few experts doubt that a very large object struck our planet 65 million years ago.

The story of how Alvarez's theory originated and how his group substantiated it is a classic example of pure scientific detection, sparked by those unpredictable flashes of insight that mark so many brilliant discoveries. It is also one to delight the three princes of Serendip and the sponsors of father-son days.

Practicing without a license

Luis W. Alvarez is a tall, well-built, silver-haired man. His deep, booming voice is colored with the broad tones of the Far West. He looks at least 10 years younger than his age—71 in June—and acts it. (During an interview in his office at Lawrence Berkeley Laboratory in Berkeley, Calif., he casually asked me if I'd like to have lunch with him in Monterey, about 100 miles to the south. I looked at my watch. It was a quarter to 12. How, I asked, could that be managed? "Oh, we'll just drive to my plane and fly down for a bite and fly back," he answered. It turned out that he flies a fully instrumented twin-engine Cessna.)

His range of interests in physics is eclectic, to say the least. When I walked into his office, I saw photographs of Egyptian pyramids adorning the walls—and on a table a large plastic model of the pyramid of Chephren at Gîza. They were mementos of the time, some 16 years earlier, when he and a team from LBL sought to find hidden chambers within the pyramid by probing its interior with cosmic rays [PS, March '67]. His 1968 Nobel Prize was awarded for improvements in the hydrogen bubble chamber and the discovery of new resonance states of elementary parti-

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cles. He has invented a variable-focus lens that is used by optometrists and is developing a self-contained stabilizer for high-powered binoculars.

"Now," he laughs, "I'm practicing geology without a license."

His son, Walter, *is* licensed. A professor of geology at the University of California, Berkeley, Walter Alvarez had begun in the late 1970s to study a sedimentary-rock formation found near Gubbio, in central Italy. The rock had been deposited at the bottom of the sea, only to be later upthrust and eventually exposed to view by the ubiquitous human agency of road-building.

This rock, with layers of pastel-pink and white limestone, is very special. It embraces the terrible span, 65 million years ago, when so many species made a rapid exit. That span is called the Cretaceous-Tertiary (C-T for short) boundary, for the two major geological time periods on either side.

In the Gubbio rock's lower, paler limestone layer, paleobiologists had found abundant remains of minute sea creatures called forams, which had calcium-bearing skeletons. Lying between the lower and upper limestone layers was a thin stripe of reddish-brown clay, in which the foram fossils are utterly gone. They begin to reappear in the pink upper layer.

The legend in the rock is clear. It matches the progress of the C-T extinction, in which calcareous marine animals, abundant in the Cretaceous Period, disappeared abruptly for a time (which accounts for the interruption in the formation of limestone—calcium carbonate) and then made a comeback in the Tertiary.

Walter Alvarez, among others, had used the technique called magnetic stratigraphy to date the events in the Gubbio and other rock samples. The technique relies on the fact that periodic reversals of Earth's magnetic field are recorded in rocks. The transition zone, the clay boundary, could at least be located roughly in time—between two incidents of magnetic reversal. But exactly how many years did that barren, two-centimeter-thick clay layer actually represent? What was the duration of the catastrophe? Those were the questions Walter discussed with his father.

The two men had coincidentally been seeking a project that might combine their interests—a family venture. In response to Walter's queries, Luis Alvarez conceived the idea of using a chemical marker by which the clay layer's time span could be measured.

The key to this idea is that sediments deposited slowly on the ocean floor, where limestone is formed, invariably incorporate some debris from space. These are primarily meteoritic materials, which drift down onto the planet at a known, constant rate. This space dust is chemically different from Earth-surface material. And among the elements that are far more abundant in meteorites than on Earth's surface are members of the platinum group, including the silvery-gray metal iridium.

Elements of the platinum group have an affinity for iron. They were depleted from Earth's surface when huge amounts of molten iron traveled to the core in the planet's infancy. Thus iridium is several thousand times as common in meteorites as it is on Earth. Standing out from the normal incidence of crustal elements, and with its rate of deposition known, meteoritic iridium could therefore serve as a cosmic clock for the rocks in which it was found.

> "It was a provocative discovery that has completely altered the course of evolutionary debate"

But measuring small quantities of iridium is devilishly difficult. Luis and Walter Alvarez were lucky enough to have access to a unique talent right on the UC Berkeley campus—a team of LBL nuclear chemists, Frank Asaro and Helen Michel, famous for super-precise detective work using an analytical technique they helped refine: neutron activation analysis, or NAA. In NAA, a sample of material is bombarded by neutrons inside a reactor so that it becomes radioactive. (The UC Berkeley unit is a small, 1,000-kilowatt research reactor.) The spectrum of energies of the gamma rays emitted from an irradiated sample, sensed by a germanium detector, provides a signature for each radioisotope created. Working backward, the chemists can deduce which elements were originally present in the sample—and in what quantity. In the hands of adepts, NAA is capable of exquisite delicacy.

When they were approached by the Alvarezes to analyze the Gubbio sediments for iridium, Asaro and Michel were not sanguine. "We'd tried to measure iridium from meteoritic dust once before as a marker for stratigraphic dating of soils," remembers Asaro. "But we couldn't detect any."

Bearded and dapper, Frank Asaro speaks with a measured care that seems to reflect the precision of his analyses: "We looked at samples from the Gubbio boundary and didn't see much. But we had just received a much larger and more sensitive gamma-ray detector, so we tried it."

The results were totally confounding. They found iridium all right, but it had not been deposited at a more or less constant rate, as they had all expected. Nor was it just barely detectable. Instead, says Asaro, "We found a huge increase in iridium at the clay boundary, much larger than our proposed, pre-experiment explanation could tolerate." The amount of iridium in the clay layer jumped more than 30-fold over the level in Cretaceous limestone, then quickly fell back to normal in the Tertiary. Here was a totally unexpected iridium spike that came just at the time of one of the most devastating mass extinctions. It was a provocative discovery that has completely altered the course of evolutionary debate. And it happened quite by chance.

"When we considered," says Luis Alvarez, "that this iridium peak was exactly synchronous with the C-T boundary, it seemed not to be a coincidence." The excess iridium strongly suggested an extraterrestrial origin: Perhaps it came from a supernova, a favorite candidate in mass-extinction theorizing. If a supernova exploded close enough to Earth, the reasoning went, it would either kill off many species directly via radiation or cause lethal mutations. It would also cause a profound alteration in world climate that could wipe out species accustomed to tropical conditions. But in order to have injected the amount of iridium found in the clay layer, the LBL team figured, the supernova would have had to have been a mere tenth of a light-year from Earth. The chance of that happening in the last 100 million years is one in a billion.

"Unlikely though it was," says Asaro, "the supernova theory needed to be tested. And it was testable. If you make iridium in a supernova, you make other elements with it. One of

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them is plutonium 244, which is radioactive and has a half-life of more than 65 million years. So if it was laid down along with iridium, it might still be there. We looked for it but didn't see anything like the levels that should have been present."

There was another test available. Isotopes forged in the intense neutron furnace of a supernova will appear in different ratios, depending on the type of star. Or as Luis Alvarez puts it, "Cookies from different ovens have different tastes." When Asaro and Michel measured the relative abundance of two different isotopes of iridium in the boundary layer, they found that the ratio closely matched the ratio that identified iridium naturally occurring in our solar system. "We concluded," says Asaro, "that the iridium in the C-T layer came from an extraordinary extraterrestrial source. But it was within the solar system."

Then the Alvarez team found an even larger iridium spike—more than 160 times normal—in boundary specimens from Denmark's Stevns Klint sea cliff, 50 kilometers from Copenhagen. Next, they found a spike in New Zealand, important because it showed the iridium layer to be worldwide, as were the extinctions.

Following the reports of the Gubbio, Denmark, and New Zealand results, other researchers began finding similar iridium spikes from many other sites. Two European geologists, Jan Smit and Jan Hertogen, found anomalous iridium in a C-T-boundary rock in Caravaca, Spain. The coincidental extinction of planktonic marine organisms, they said, "was abrupt without any previous warning in the sedimentary record." Soon the finds were flooding in—from Italy, New Mexico, from deep-sea cores wrested from 4,200 meters below sea level off South Africa . . . from Haiti, Russia, North Africa.

In the years since the original Gubbio find, says Frank Asaro, "the number of sites where an iridium spike has been found in conjunction with the boundary layer has grown to 36 or 37—it changes almost daily."

As soon as this global distribution became evident, the question posed to the Alvarez team was clear but puzzling. Sixty-five million years ago, something from within the solar system bombarded Earth with material in such a way as to leave its chemical fingerprint all over the world and to cause mass extinctions of an incredible variety of creatures. But what?

"I went through two theories a week for about a month and a half," says Luis Alvarez, "including novas of the sun and solar flares. Each was matched against physical and biological criteria. The event had to be something that was probable in a period of 100 million years or so. It had to account for the geochemical evidence. And it had to be capable of initiating the biological extinctions. All but the last of our theories went down the drain, and that one was an asteroid impact. . . . I calculated that one big enough to bring in the observed iridium—10 kilometers in diameter—could do the job. And the probability of such an asteroid hitting Earth, a calculation made for us by E. M. Shoemaker of Caltech, was one every 100 million years—just right."

Originally, Luis Alvarez believed that the dust cloud raised by the impact would last for several years, turning day into night. That, in turn, would suppress plant photosynthesis and rupture the fragile network of food chains with fatal consequences. Now, however, the LBL team has revised that scenario to a degree. Calculations run on the same Los Alamos Laboratory computer that designs nuclear weapons show that a large fraction of the dust particles would blast from the surface in ballistic orbits and be distributed worldwide within hours. The dust cloud would remain suspended for months, not years. Other calculations show, says Alvarez, that this would reduce surface temperatures to around −18 degrees C (zero F) for six to nine months.

> **"Now everybody believes that a great big chunk of rock hit Earth 65 million years ago"**

"My own view now," says Alvarez, "is that the extinctions were caused by three or more things: certainly darkness, certainly cold, perhaps acid rain produced by the formation of nitrogen oxides, and possibly a later global warming, by the greenhouse effect, if the asteroid hit the ocean and sent great quantities of water vapor into the atmosphere.

"What everybody—with quotes around everybody because there are always some holdouts—believes is that a great big chunk of rock—call it a meteorite or an asteroid or what you will, but it was 10 kilometers across—hit Earth 65 million years ago and that it caused the extinction of the forams and lots of different life forms in the oceans at the least. The evidence for that gets stronger every day."

One vital piece of evidence was reported last October by Charles Orth and his colleagues at Los Alamos. They found the telltale iridium spike at the C-T boundary in rocks from northern New Mexico, the first such anomaly in what geologists call a continental, or non-marine, site. All the previous samples had come from sediments that had been submerged in the oceans for 62 million years and then upthrust three million years ago or were in fact still submerged. The significance is that some geologists felt the abnormal amounts of iridium could somehow have been concentrated from sea water in a short period of time. But this could obviously not be true if the iridium-bearing layer had never been submerged.

The LBL team *thought* it had discovered such a site earlier than Orth, in 1981. The mistake illustrates the pitfalls that await chemists trying to detect elemental traces of a few parts per billion. Around LBL it's called the wedding-ring thing.

"The first continental boundary layer we looked at was from near Fort Peck, Mont.," Frank Asaro told me. "We found a nice iridium peak in the very first sample. And the more samples we analyzed, the more peaks we found. This became rather suspicious. So we looked at a blank standard in the capsule from the reactor, which should have had no iridium at all, and that had an iridium peak. Then we analyzed the aluminum foil the samples were wrapped in, and *that* had iridium. Well, that just couldn't be.

"One day I was watching a technician help grind and wrap the samples. I noticed that she was wearing a wedding ring, and I asked, 'By the way, is your ring white gold or platinum?' She said it was platinum, and I knew instantly we'd been had. Platinum jewelry is normally hardened with about 10 percent iridium. And if you do a rough calculation, the amount of iridium rubbed off the ring every minute is about a hundred times higher than what we can detect in the samples we're analyzing."

The fate of the technician is not recorded in the scientific literature. PS

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Flue-heat retriever

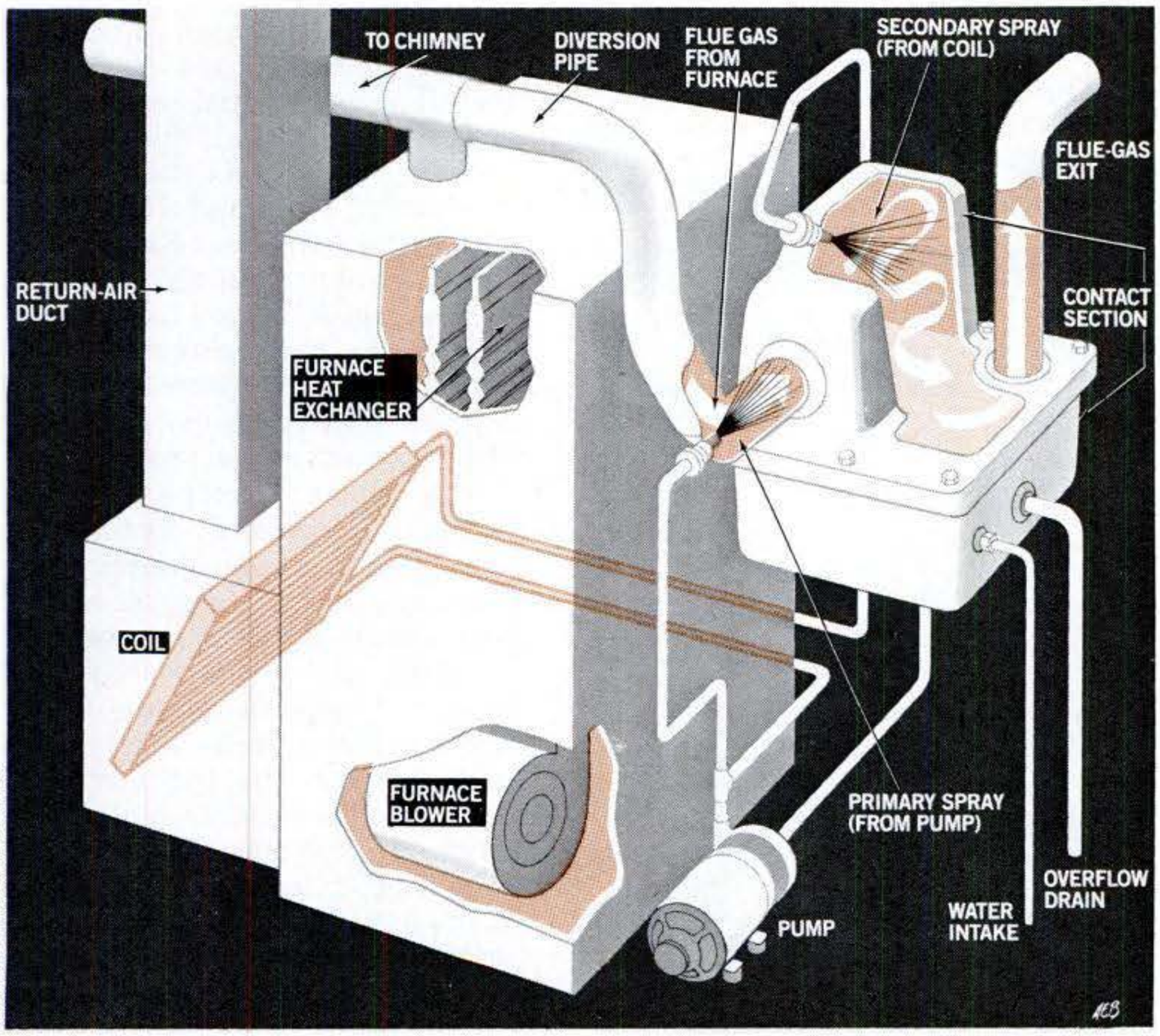
uses water spray to cut your losses

Install it on a "fuelish" furnace—you could slash your fuel bill by 30 percent

By EVAN POWELL

I started this project with a conventional upright gas furnace containing a very typical (and typically inefficient) atmospheric burner. When I finished, the furnace looked rather strange—with a double smoke pipe and waterline harness—but it was now well into the upper echelons of high-efficiency performance.

The reason for the strange new look and for the improved performance was an add-on flue-heat-recovery device from Sears called the Heat Extractor.



DRAWING BY ADOLPH BROTMAN

Sears Heat Extractor's primary components are located in the contact section, which you install in the diversion pipe, a new branch of the flue pipe. The Heat Extractor system also contains a pump (which is wired to start when the burner starts), a heat-exchanger coil (located in the return-air duct of the furnace), a cold-water intake, float valve, and drain. Here's how it works: When the burner starts up, the pump turns on and forces water through the primary and secondary spray nozzles. This creates a venturi effect and draws the flue gases into the contact section. As the water is sprayed through the hot flue gases it removes much of the heat, and the hot water (at about 100 deg. F) falls into the reservoir of the contact section. From there the pump circulates most of the hot water to the coil in the return-air duct, where the air is preheated before it reaches the furnace's heat exchanger. A small amount of the water is diverted at the T-fitting above the pump and provides the water for the primary spray. The water for the secondary spray comes from the outlet of the heat-exchanger coil. Once the flue gases have passed through the contact section, they are exhausted via four-in. flexible duct.

(It is available for oil furnaces as well as for gas.)

Such gadgets are not new; most now on the market replace a section of flue pipe and consist of a series of tubes and a blower that forces the flue gases through the tubes, where some of the heat is extracted.

But the Sears Heat Extractor is different. It captures the waste heat in a spray of water, then routes the hot water to a heat-exchanger coil, where it preheats the return air from your house before the air gets to your furnace. The more waste heat your furnace generates, the greater the potential for savings. Even Sears laboratory, usually conservative in its ratings, states that the new Heat Extractor system reduces fuel consumption by up to 30 percent. At the catalog price of $559 (and it's eligible for federal tax credits), it should quickly pay back its cost in money saved on fuel. But installation can add several hundred dollars to the cost if you don't install it yourself. And that job, as I found out, is more than a simple project.

Heating basics

In the normal course of operation, part of the heat from the burner of your furnace warms a steel heat exchanger. The furnace blower pulls air into the furnace from the living area of your house through the return-air duct. From there it passes across the outside of the heat exchanger and picks up heat. Then the heated air is distributed back to the house.

But that only accounts for part of the heat generated by the burner. Most of the remainder goes up the chimney, keeping the flue temperature around 400 to 500 degrees F. In many furnaces that accounts for almost half the heat input you pay for. That, of course, is the heat you can save with the Heat Extractor. The caption explains how it works.

Dan Benchwell, inventor of the system, told me that it was originally developed as a pollution-control device to remove particulates from the exhaust of huge commercial furnaces. Many large units are in use in government and industrial facilities, he reports. It was apparent, however, that the water spray also absorbed enormous amounts of energy from the flue gases. So Benchwell went to work to develop a residential model for waste-heat reclamation.

Like its ancestor, the Heat Extractor removes pollutants as well as heat from the flue gases. And the hydrocarbons tend to form an oily residue on top of the water. To prevent the residue from gumming up the plumbing,

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Flue-heat retriever

[*Continued*]

an overflow drain in the contact-section reservoir skims off the top layer of water at the end of each operating period. The float valve opens the water inlet to admit makeup water at each start-up.

I found that the Heat Extractor system includes all of the fittings and wiring for a normal installation. Some of the components must be assembled, but instructions are clear, and the equipment was machined carefully so everything fit. Installation takes time and patience; you may want to farm out part of the work.

You'll need at least two feet of clearance on one side of the furnace, but the unit can even be mounted in a more remote location if necessary. It can't be installed where the temperature gets below freezing, though, and you must provide both supply water and drainage.

The biggest problem I encountered was the installation of the coil. Although the cabinet is furnished, installing it required some modification of the return-air duct.

Does it work? I let a thermometer be the judge. I measured stack temperature without the Heat Extractor operating. Readings ranged from 420 to 450 degrees F. Then I took new readings in the main chimney after the retrofit. These ranged from 150 to 185 degrees. The gases exiting from the Heat Extractor measured 85.

The Heat Extractor system for oil furnaces is currently available only through Sears retail stores; the gas version is in the catalog, as well. Now inventor Benchwell is working on adapting the device for boilers, for wood and combination-fuel furnaces, and possibly even for wood stoves. It may prove to be the best retrofit answer to the creosote, pollution, and efficiency problems of solid-fuel heating. And at least one wood-furnace manufacturer is considering it for original-equipment installation. PS

Savings using Heat Extractor

Gas cost ($) (heating)[1]	30% annual saving ($)	Tax credit (15%)($)[2]	First-year saving ($)	Payback (years)
640	192	120	312	3.5
800	240	120	360	2.8
960	288	120	408	2.4
1,120	336	120	456	1.9
1,280	384	120	504	1.8
1,440	432	120	552	1.6

[1] These annual figures are based on American Gas Assn. data. Costs vary with location. If your annual gas bill includes fuel for cooking, deduct 20 percent to arrive at the cost of gas for heating.

[2] The tax credit is allowed on the cost of the product and installation. These numbers assume an installed cost of $800.

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Car 54 Where Are You?

Maximum detection range is wonderful, but it's far from the whole story. In some ways, radar detectors are like smoke alarms; you want to make sure that you don't miss anything, but you don't want a lot of false alarms. ESCORT won't disappoint you. Beyond that, when a smoke alarm sounds off, the most pressing thing on your mind is: Where is the fire? Is it ahead of you, behind you, above you, or below you? In the same room, or at the other end of the house? Your senses can help you find fire, but, on the highway, you can't feel or smell radar. ESCORT is your sixth sense.

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Polarization
—a look at your outlets' hot slots

If your house was built since the 1930s, chances are that the electrical outlets are a bit asymmetrical. Look closely—you'll see that one of the slots is slightly larger than the other. That slot is connected to the neutral leg of your home's electrical wiring. Behind the outlet plate, the neutral slot is connected to a white wire, which runs to the fuse box or circuit-breaker panel and connects to the neutral bar. The entire system is polarized.

The two-sized slots are part of a method to continue your home's polarization out to the live and neutral wires of a lamp cord, extension cord, or, more recently, an increasing number of home appliances, tools, TVs, and radios.

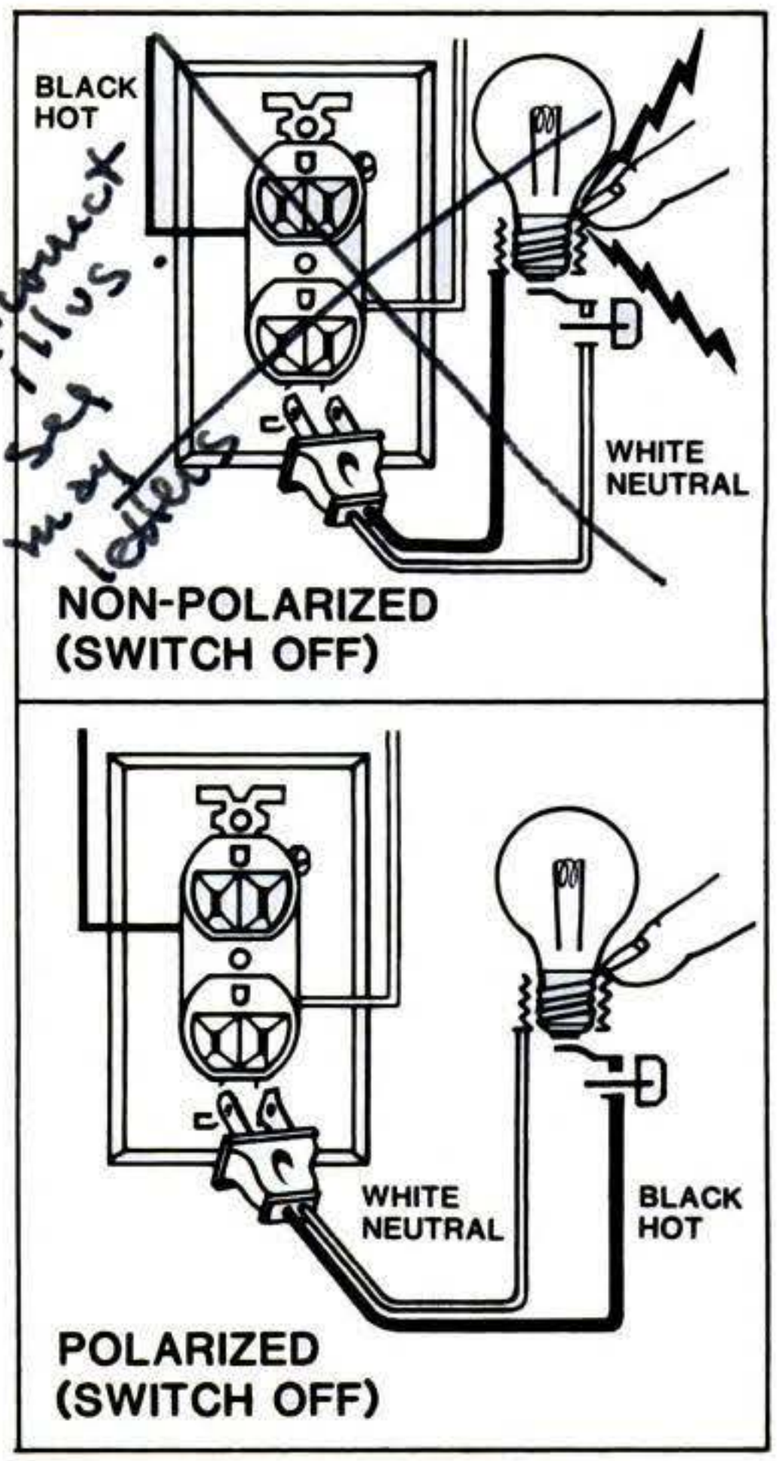
Why? To ensure that the hot wire—the ungrounded leg of your home's electrical system—is switched. That is to say, when a lamp is turned off, there's no possibility that a person who comes in contact with it can get a shock, which could happen if the lamp were faulty.

A danger can exist, too, in perfectly good lamps. If a lamp is not polarized, a person changing a light bulb who comes in contact with the bulb's base could receive a shock since he, in effect, completes the circuit to ground.

Polarized plugs are required on all Edison-base lamps made for sale in the U.S., as well as in all flat-wire, two-conductor extension cords. Three-wire cords are polarized by virtue of the position of the prongs on the plug—the third prong determines the location of the other two.

Never try to defeat the polarization of an appliance or try to force a polarized plug into a non-polarized outlet or extension cord. You may not only create a safety hazard but also destroy the outlet. A damaged outlet could mean live prongs left exposed or poor contacts that could result in overheating.

Many manufacturers have polarized devices on the market. For instance, General Electric, which provided the diagrams below, includes such items as a grounding triple-tap adapter, socket adapters, and screw-in twin taps.—*Charles A. Miller*



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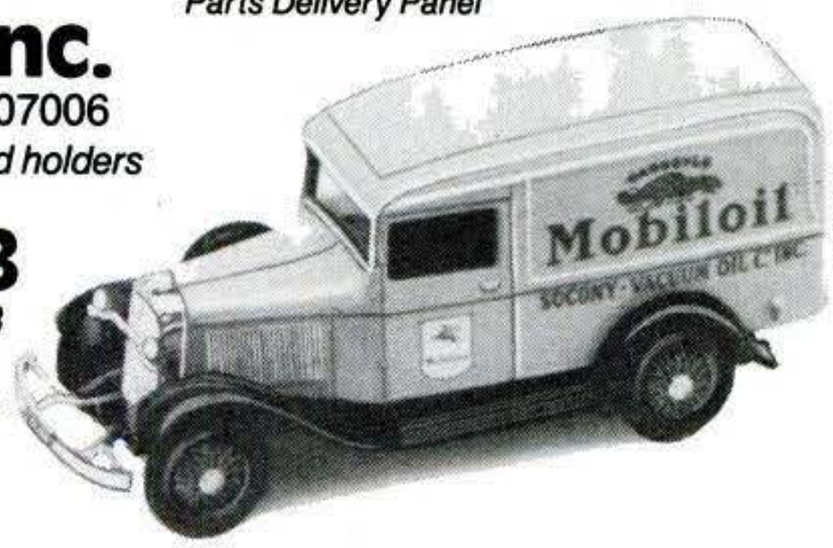

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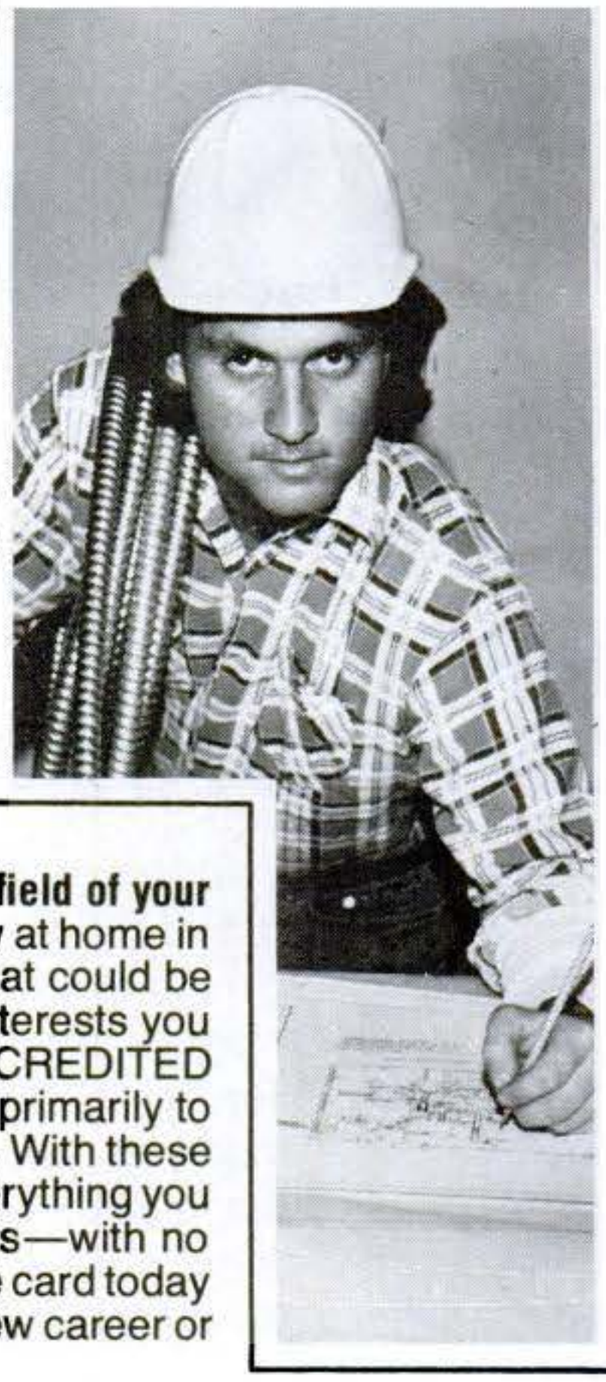

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Lighter is better: composite helicopters

How can helicopters be made to carry bigger loads farther, faster, and higher? One approach is to make a basic component lighter.

A new research program to develop strong composites to replace metal in the airframe structure and skin of helicopters promises to reduce weight by 22 percent and cut construction costs by 17 percent over conventional metal airframes. Two major helicopter manufacturers, Sikorsky Aircraft and Bell Helicopter Textron, are participating in the 3½-year project, which is sponsored by the U.S. Army's Advanced Composite Airframe Program. The $11.6 million project will use the dynamic systems of the Sikorsky S-76 and Bell 222, both current production helicopters.

The Sikorsky design, shown in the photo as a one-fifth-scale wind-tunnel model, will weigh 8,470 pounds, including six combat-equipped men and two pilots. The Bell version (drawing) will be lighter at 7,500 pounds (with two combat men). Both will be powered by turboshaft engines.

Another goal of the program is to improve crashworthiness. The composite airframe, made of Kevlar, graphite, boron, and polyamides for parts exposed to heat, will have to withstand a 42-foot-per-second impact and a 20-fps sink rate, about that of a parachute-jumper landing.

Composites are already in use in civil and military planes—in the skin and in many fairing parts, including flaps and control surfaces. Results of the research project may not only improve performance of new helicopter designs but also be incorporated in current production aircraft for comparable improvements in performance and cost.—*Ben Kocivar*

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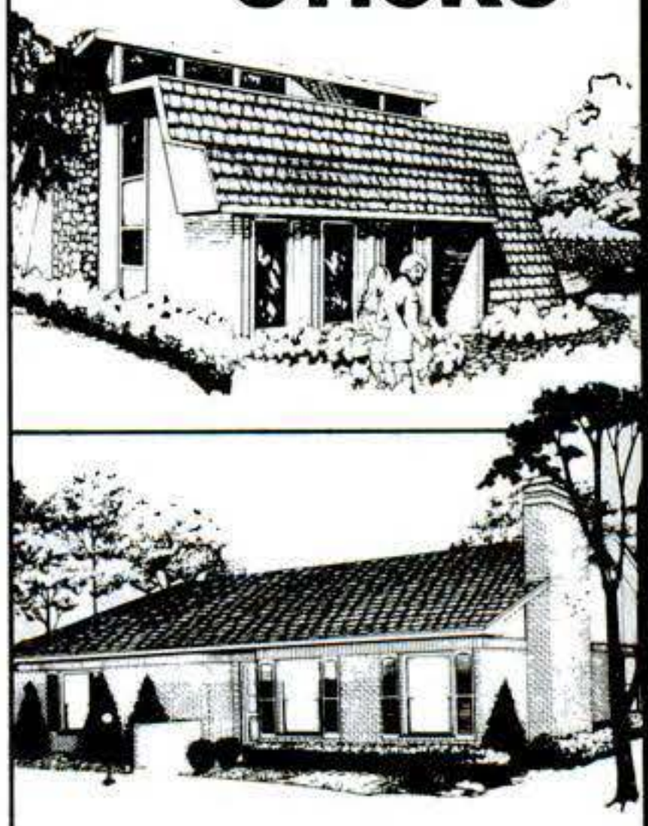

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Popular Science

PS | What's News

How do you design a plane that radar can't detect? At first blush, it sounds impossible.

It isn't. The secret: Shape the parts to produce weak echoes, make them of special anti-radar materials, paint them with radar-absorbent coatings, and combine all of that with some electronic magic carried aboard.

Many companies are working on such a plane, and the final configuration has not yet been determined. The cover painting, by Dean Ellis, shows one possible shape; you'll find others under active study in the article by Jim Schefter.

Computers, computers

With the advent of the relatively inexpensive home computer, we are entering a revolutionary time. Two computational straws in the wind:

Freshmen entering Drexel University next year will be required to buy computers for classroom work. "We have been moving steadily in this direction for the last few years," said Bernard P. Sagik, vice president for academic affairs. "We realize that there was simply no way our students could get enough time with our present time-sharing arrangement to become truly familiar with the computer."

No brand of computer has been chosen, but college officials say it will probably be a model in the $1,000 range.

This month may see the beginning of a totally new service. Travelhost, a Dallas-based company, says it will begin installing computers in hotel rooms across the country. In the news release, the devices sound like teletext terminals [PS, Jan. '81]. By pressing a few keys, says the company, guests will be able to send and receive messages, make or change airline reservations, check addresses and menus at restaurants, order flowers and gifts, get stock-market quotations, and take advantage of scores of other services. The terminal weighs 3.5 pounds and will use the in-room television set for display. A guest will turn the computer on, slide a credit card into a slot for billing, and gain instant access to hundreds of communications and information services on network.

Energy crisis over?

The lines at service stations have disappeared, and gasoline is plentiful—though a bit expensive. The cry from some quarters is loud: The energy crisis is a thing of the past. Such statements, says the International Energy Agency, are not only wrong but dangerous. It is true that world energy consumption is down seven percent since 1979. Part of that is due to conservation efforts. But a lot of it is the result of the worldwide recession. And energy use will shoot up when economic conditions improve.

One problem is that the so-called oil glut has lulled us into a state of complacency. Efforts to switch industries and utilities to coal have almost stopped. The synfuels industry is dead. No new nuclear plants have been ordered in years, and construction has stopped on others. Thus when oil use increases sharply—perhaps by the late 1980s—we're going to be caught short. New plants of any kind can't be built in a few years; they take decades. So once we get in a bind, it may take years to get out.

In the meantime, we could be caught in a situation that would make the last so-called energy crunch look mild. And we may well have to pay for today's complacency with sharply higher oil prices, a return of gas lines, factories shut down for lack of fuel, and soaring energy-related unemployment.

Economic forecasting is a tricky business, and not all economists agree with the timetable, but there seems to be little doubt that we're headed for tough energy times. If we're going to do anything about it, the time to start is now.

Electronics in the Far East

- Digital audio-disc players [PS, Nov. '81] are off to a fast start in Japan. They cost $600 to $1,000, but they're selling at twice the anticipated rate, and most outlets have waiting times of a month or more. The five-inch silvery discs use beams of light to play back material stored in a digital code. U.S. marketing may start later this year.
- Hitachi and Sharp have begun making automobile dash displays out of liquid crystals—the kind used in most digital watches these days. The units are multicolored, and numbers are bright enough to view in full daylight. Japanese designers are working with new ways of presenting information; for example, a Sharp speedometer uses a sort of segmented snake to indicate speed. The faster you go, the longer the snake grows. As you exceed the speed limit, the color changes from white to red. The panels are already in some Japanese cars, and samples have been sent to Chrysler and GM.
- Nippon Electric Co. has built an advanced integrated circuit that can store a million bits of information. It will be used first as a generator of the complex characters needed in Japanese text-editing machines.
- Remember programmable and linear-tracking turntables? Both have technical advantages, and both have been expensive. Until now. Aiwa has introduced a new programmable, linear-tracking table at a Japanese trade show. Projected price: about $162—less than many high-quality standard units.

Anybody out there?

Back in 1960, Dr. Frank Drake used one of the radio telescopes at Green Bank, W.Va., to listen for intelligent messages from outer space. He didn't hear any. A lot of other scientists have proposed since then that we set up a regular program to tune in on messages from other intelligent races in the universe. Now NASA has put $1.5 million in the budget to buy a special receiver. It will be hooked up to existing radio-telescopes, including the world's biggest ear, the 1,000-foot dish at Arecibo in Puerto Rico. Because nobody knows on what frequency extraterrestrials might be broadcasting, the analyzer will check some 10 million frequencies simultaneously.

The problem is finding regular patterns—if any—buried in all the radio noise generated by stars, planets, and clouds of gas throughout the universe. There is still skepticism in the scientific community over whether the search will find anything. But can you imagine the effect it would have on all of us if one day we intercepted a faint "hello" from somewhere out there in the universe?

Editor-in-Chief

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Double-shell houses

At last we know why they work

Mastin house, a classic double-shell begun in 1978, was modified last summer to improve performance. Roof glazing (photo above) was removed and replaced with much smaller area of operable skylights (photos top and right). Air plenum for convective air flow was blocked, and insulated ducts and a thermostatically controlled fan were installed to draw hot air from the top of the solarium and deliver it to crawl space below the lower level, to be stored for use at night. Mastin (shown with author in top photo) also removed insulation from attic roof and beefed up ceiling insulation to R-60.

Tests back up both the concept and its critics: It appears the houses work well—but for the wrong reasons

By V. ELAINE SMAY

MIDDLETOWN, R.I.

"This is a controversial house?" I thought, with something close to incredulity, as I entered an asphalt drive in this suburb near Newport and faced a gray-shingled Cape Cod cottage, a pleasant but ordinary rendering of a New England stereotype.

Once inside, though, it became apparent that this was no ordinary Cape Cod. The afternoon sun streamed in through skylights in a mostly glass solarium, spotlighting hanging plants and pots of white chrysanthemums. From inside it looked like a passive-solar house.

But it's not an ordinary passive-solar house, either. I got my first confirmation of its true thermal nature when I looked out a north window. Beyond the glass, a few inches away, was a second window. Wood slats, a fraction of an inch apart, bridged the gap between on all four sides. Looking closely between the slats I could see that the wall was hollow. And that's where the controversy begins.

The house, which belongs to Robert and Elizabeth Mastin, was one of the first double-shell houses built. The north wall is one part of a complete air plenum that envelops the house on four of its six sides. It includes the solarium, the attic, the space in the north wall, and a crawl space under the lower level. According to the original theory of double-shell houses, as postulated by the inventor, San Francisco architect Lee Porter Butler, heated air from the solarium is supposed to flow by natural gravity convection around that plenum, distributing the heat evenly to the house and storing the excess in the crawl space and the earth below for use at night.

No sooner had one of these houses been built and publicized than the critics attacked [PS, Dec. '79]. They started by disputing the basic theory, then went on to question performance claims, cost effectiveness, and even the safety of a house with a plenum through which fire might quickly spread. Just as vociferous were the proponents: owners who lived in the houses, architects who designed them, and others who just liked the idea of an energy-efficient house with no mechanical systems, no massive masonry walls, no jugs of water, and plenty of windows. About the only thing all agreed on was the need to monitor some of these houses and see: (1) if they work, and (2) how they work.

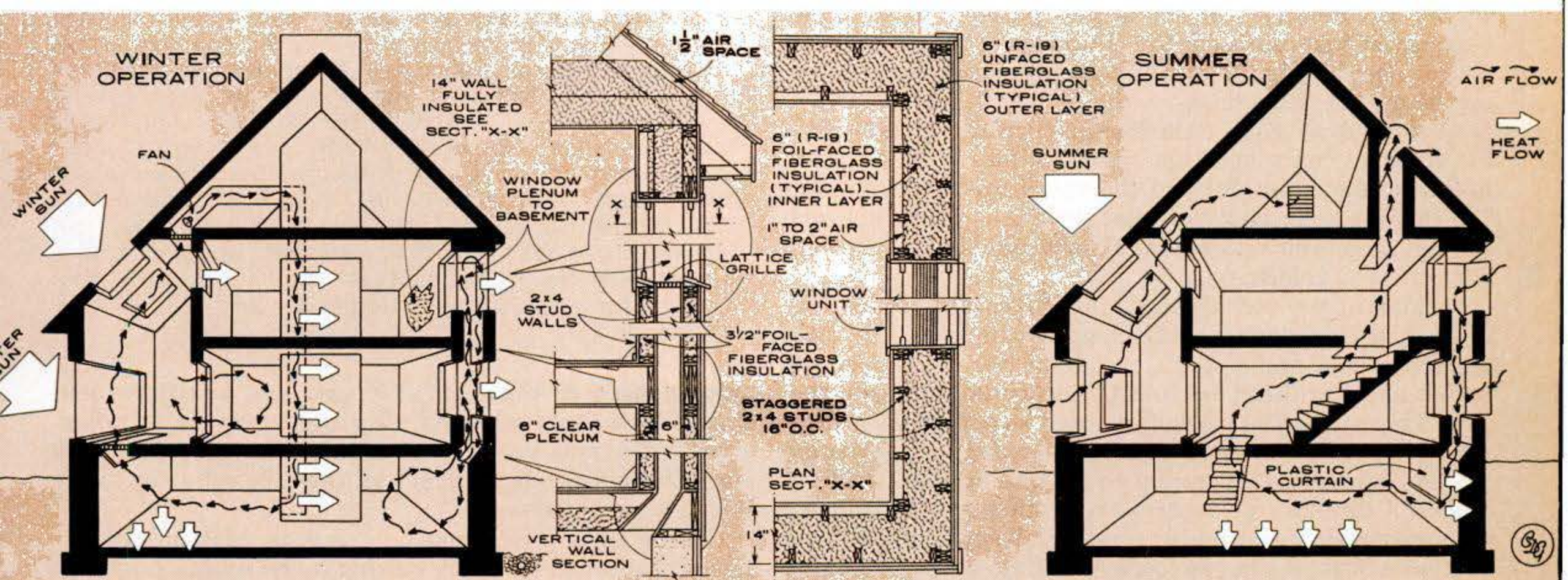
Now such studies have been done and the results analyzed. One of the most comprehensive used the Mastin house as its guinea pig. The conclusion: The house works—but for the wrong reasons.

With that evidence in hand, Mastin, who has his own design firm (Natural Energy Design, Inc., 1355 Green End Ave., Middletown, R.I. 02840), and a few others are modifying the basic double-shell concept in ways that may make it work even better.

The Brookhaven tests

In the winter of 1980, a team from the Department of Energy and the Environment of Brookhaven National Laboratory delivered a carload of instruments to the Mastin house. They installed thermistors to measure temperatures in nine locations, three recording hygrometers to measure relative humidity, and two recording pyranometers to measure solar insolation. To measure the exact amount of auxiliary heat used they installed a 1,500-watt electric heater on each floor, each controlled by a thermostat set at 65 degrees F. (The Mastins were instructed to keep their fireplace and wood stove cold.) A data logger was put on each floor to record the readings of the thermistors every 20 minutes and the number of seconds that floor's electric heater had been on. Monitoring took place in parts of January, February, and March. More tests were run in July. The following winter, thermocouples were installed to monitor the temperatures below the slab. "We collected data off and on for almost a year," says Mastin. "My wife got a little tired of all those instruments and wires hanging around."

Continued



Mastin's Hybrid Geotempered Envelope design has super-insulated walls on north, east, and west: double-stud walls with 12-in. (R-38) insulation. Attic insulation is R-60; foundation, R-10. Double windows have plenums that open into basement. On a sunny winter day (left), 800-cfm fan draws hot air from top of solarium through insulated duct in attic and down a duct in masonry chimney. There it loses heat to the mass. Duct opens into basement, where warm air loses more heat to the mass there and to the earth below. Air is then drawn up through grates in solarium floor, and cycle repeats. In window plenums, air near outer glass cools and falls to basement, displacing warmer air, which rises into plenums. On winter nights, solarium is kept warm in similar way, and masonry chimney releases heat to house. In summer (right) attic vents draw solarium heat through opened trap door. Attic fan draws air through open outer windows, down plenums to basement, up stairwell, out attic.

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It took Brookhaven months to analyze all the data. But finally the report was published. To begin with, it confirmed that the house needs very little auxiliary heat. "It used less than one-quarter the purchased energy of a recently built conventional house of comparable space," the report states.

Butler, however, had claimed that his houses need no auxiliary heat. ("They can be designed that way," he insists in rebuttal, "but the Mastin house was not. By upgrading the insulation and glazing, reducing infiltration, and leaving the earth exposed in the crawl space rather than covering it with a concrete slab, the house could be made to stay at 65 without auxiliary heat." He claims that many of his houses in cold climates do just that, though he knows of none of these that has been monitored.) Still, by most standards, the Brookhaven tests confirmed that the Mastin house performs very well.

But the tests didn't do much to confirm the theory. Stratification was an obvious problem. For a typical week in January, on sunny days the temperature in the attic always rose to 90 degrees, topping out at 106. In the crawl space, however, temperatures remained between 45 and 55 for the entire period. Temperatures on the three living levels reflected a corresponding stratification. "Auxiliary heat is needed on the lower level even when the upper level is overheated," the Bookhaven report notes. During a typical two-day period in January, the heater on the top floor was on five percent of the time while the one on the lower level was on 82 percent. Clearly, gravity convection wasn't distributing heat evenly through the house.

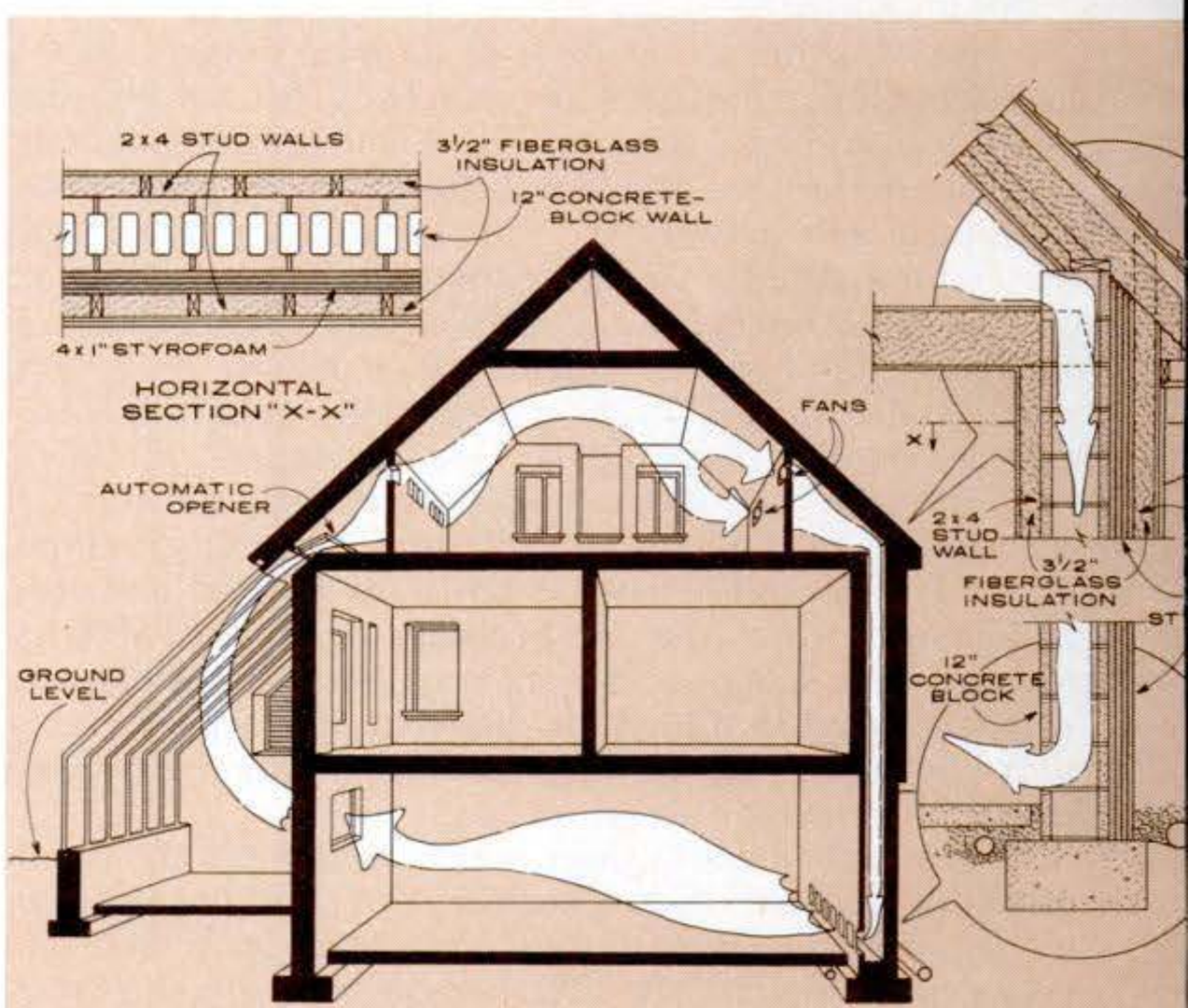
Next, the Brookhaven team attempted to measure the convective flow directly. (Actually, they instucted Mastin, who holds an engineering degree from the Naval Academy at Annapolis, Md., and he did the legwork.) "They gave me a hand-held instrument called an ionized corona probe," he reports. "Air flow through this tube affects a field of ions in a manner that is directly proportional to the velocity of the air. I did measurements at various times and all over the envelope."

What did he see? "In the heat-gain mode [a sunny day] I definitely saw air flow in the direction the theory predicts," he reports, "but it was fairly slow. At night, there wasn't any definite, consistent flow pattern. Most of the time it was just confused. But it was never static." Theory said it should reverse at night and flow in the direction opposite to daytime flow.

After analyzing the data Mastin turned in, the Brookhaven team concluded that the directions were too confused to be meaningful and the velocities definitely low. They pointed out, however, that since the volume of air is so large, a significant amount of heat could be moved even with the low velocities.

So Mastin devised a simple test to see how much the convective flow contributed to heating the house. He took building paper and a staple gun and covered the opening between the crawl space and the solarium, blocking the loop. The result: The blockage caused no performance degradation. In fact, the auxiliary heat needed was "lower by five to 20 percent (depending on insolation) with the loop blocked," Brookhaven reports. (What this didn't test, however, was Butler's revised theory, which says that the convective flow occurs in two loops—one from the basement to the solarium and the other from the basement up the north wall. Brookhaven plans to test this in the future.)

Other tests indicated that there was little effective heat storage in the crawl space and the earth below. One way they checked this was by comparing the auxiliary heat requirements for two nights with similar outside temperatures. The first night followed a sunny day; the second, a cloudy day. If, indeed, solar heat is stored in the daytime



Air flow around loop in house designed by Christopher Shipp is fan-forced. On winter days, as sunspace warms, insulated doors at top open. Fans near north wall pull warm air across upper story and down plenum in super-insulated north wall (R-40). Plenum is formed by voids in concrete blocks (for fire resistance and heat storage). (Other walls are R-30, roof is R-45, foundation is R-20.) Air exits from north wall to lower level, where more heat is stored, then returns to sunspace, and cycle repeats. At night, insulated doors at top of sunspace close. In summer they are also closed. Then warm air from house is pulled down by fans through north wall and dumped in lower level, losing heat to mass. It returns up stairwell. Root cellar (not shown) doubles as heat exchanger.

and released to the loop at night, less auxiliary heat should have been required after the sunny day. In fact, slightly less was required after the cloudy day. Still, the warmth from the earth itself did keep the solarium above freezing at all times.

Having lived in the house for a year, Mastin had surmised that it had too much glazing in the solarium roof. To test that, he installed fiberglass batts over the upper half of the double row of windows, blocking both solar gain and heat loss. With the insulation in place, "the auxiliary heat required was reduced by 25 to 50 percent," Brookhaven's analysis revealed.

Limited tests done in July indicated that the house stays cool in summer as well as it stays warm in winter. For example, one July day when the temperature outside

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Ample window area on all sides of house is one advantage of HGE houses. This is southwest corner of the Heyd house.

reached 87 degrees F and the solarium rose to equal that, the living areas of the house ranged from 71 to 74, without auxiliary cooling. Certainly the outer shell, which shades the living area from the sun, contributed to this. But the cooling tubes, a standard feature of double-shell houses in some climates, didn't seem to help much. In cooling mode, hot air is supposed to rise from the solarium and exit through attic vents, pulling fresh air that has been cooled and dehumidifed by earth contact into the envelope through the cooling tubes. During part of the Mastin tests, air flow was in the wrong direction: It flowed from the house, through the cooling tubes, and out what was supposed to be the inlet.

(Actually, the Mastin house doesn't present much of a cooling challenge. It's about a mile from the Atlantic, and prevailing southwest winds bathe it in cool ocean air on most summer afternoons.)

After analyzing all the data collected, the Brookhaven team reached this conclusion: "The low energy needs of the Mastin house are attributable mainly to the excellent insulative value of its double shell." If cost were a simple overriding consideration, the report continues, "it would be difficult to rationalize the double envelope's use over the super-insulated house."

Super-insulated houses [PS, May '81] are exactly what the name implies. They are constructed to include an enormous amount of insulation. They conserve heat so well that internal heat gain—from people and appliances—is nearly enough to carry the house, even in a severely cold climate. They rely on solar heat very little, and hence have small windows, even on the south, since windows can be a large source of heat loss.

Hybridization

But, Mastin decided, why not have the best of both worlds? His current designs blend many aspects of a super-insulated house with some vestiges of the double-shell design. He calls the result a Hybrid Geotempered Envelope (HGE).

On a lovely wooded lot south of Boston, builder Robert Green is just completing an HGE house for Robert and Nina Heyd (see photo). Gary and Kathy Brennan and their five children have just moved into another near Little Compton, R.I. Both have solariums, but there's no air plenum forming a loop around these houses. Instead, a thermostatically controlled fan takes hot air from the top of the solarium and delivers it through ducts to the basement.

The attic, foundation, and the north, east, and west walls of these houses are super-insulated (see diagram). The north, east, and west windows, however, look much like the north windows in Mastin's own house: two sets of double-glazed units. There is an air plenum at each window, but it's only as wide as the window and ends at the top (which tends to comfort fire inspectors). It does, however, run all the way down to the basement. "The true effectiveness of the double-shell design is in reducing heat loss through glass," Mastin says. "When the air between the windows is colder than the air in the basement, it's going to drop and displace the warmer air there, which will rise.

"The plenum also reduces infiltration," he points out. "Yet when you need ventilation, you can open an interior window and get it, without a blast of cold air." This mitigates the need for an air-to-air heat exchanger [PS, Jan.], which super-insulated houses often require. And since the windows aren't horrible heat losers, HGE houses can have a good many, even on the north side.

Mastin is not alone in modifying the double-shell concept. In fact, a Pennsylvania designer, Christopher Shipp (R.D. 1, Box 331D, West Grove, Pa. 19390), has come up with an almost identical design, including both super-insulated walls and double windows with air plenums connected to the crawl space or basement. Shipp is also doing variations of the double-shell house that are closer to the original concept, but using fans to force the air flow (see diagram). At least, he intends that these houses use fans. So far the owners of the house in our photo haven't installed the fans. "They only spent $60 on electricity to heat the house last winter, so spending $200 on fans seems needless," Shipp reports.

How do these hybrid designs compare in cost, performance, and livability with super-insulated houses?

"The best-performing houses anywhere are the super-insulated houses," Mastin admits. "They are also the most cost-effective to build. But their obvious shortcoming is lack of light, views, and natural ventilation."

If you count the solarium as an extra expense (about the same per square foot as the rest of the house), Mastin's HGE-type houses cost a good bit more to build than super-insulated houses. "But if you compare the cost with that of a super-insulated house with a sunspace," Mastin says, "the only cost increase is for the double windows and their plenums—about $200 per window. And you don't have the cost or nuisance of window insulation."

The auxiliary heat requirements for super-insulated houses generally come out to be even less than what the Brookhaven tests showed Mastin's house to need. Preliminary monitoring of one of Mastin's HGE houses, in Southington, Conn., suggests that its heat needs are in the same ballpark, though somewhat more than the most efficient super-insulated houses. More such data will be forthcoming. Mastin spent the past summer modifying his own house to make it more like the hybrid design (see opening page). Now Brookhaven has brought back the instruments and will remonitor the house this winter.

Just what type of house is the most livable is a highly personal matter. "I didn't want a strictly solar house because I didn't want to cut down all my trees," says Robert Heyd, gesturing toward a stand of stately oaks to the south of his house. "And I didn't want a super-insulated house without much window space."

The Brennans are delighted with the choice they made. "I checked out everything," says Kathy. "I visited some passive-solar houses with whole south-facing glass walls. They turned into an oven during the day, then cooled off just as fast at night. I checked out others that had a basement full of rocks, and some with water drums in the living room—that really turned me off. With all the other designs I read about, it seemed we had to give up something. This was the only one that had everything." PS

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Invisible bomber

—secrets of the plane that radar can't see

Airmen call them "stealth" planes. To enemy radar, they can look like hummingbirds

By JIM SCHEFTER
ILLUSTRATION BY DEAN ELLIS

Shaped like a broad, flat wing with only a smoothly blended windscreen revealing its cockpit, the bomber skimmed across barren polar terrain at nearly 600 mph. Barely 400 feet below, ice floes vibrated to the roar of its concealed jet engines. The early-warning radar fence lay behind, its operators unaware that the first line of defense had already been penetrated.

More radar waited ahead. Hugging the terrain to take full advantage of hills and valleys, the flying wing crossed

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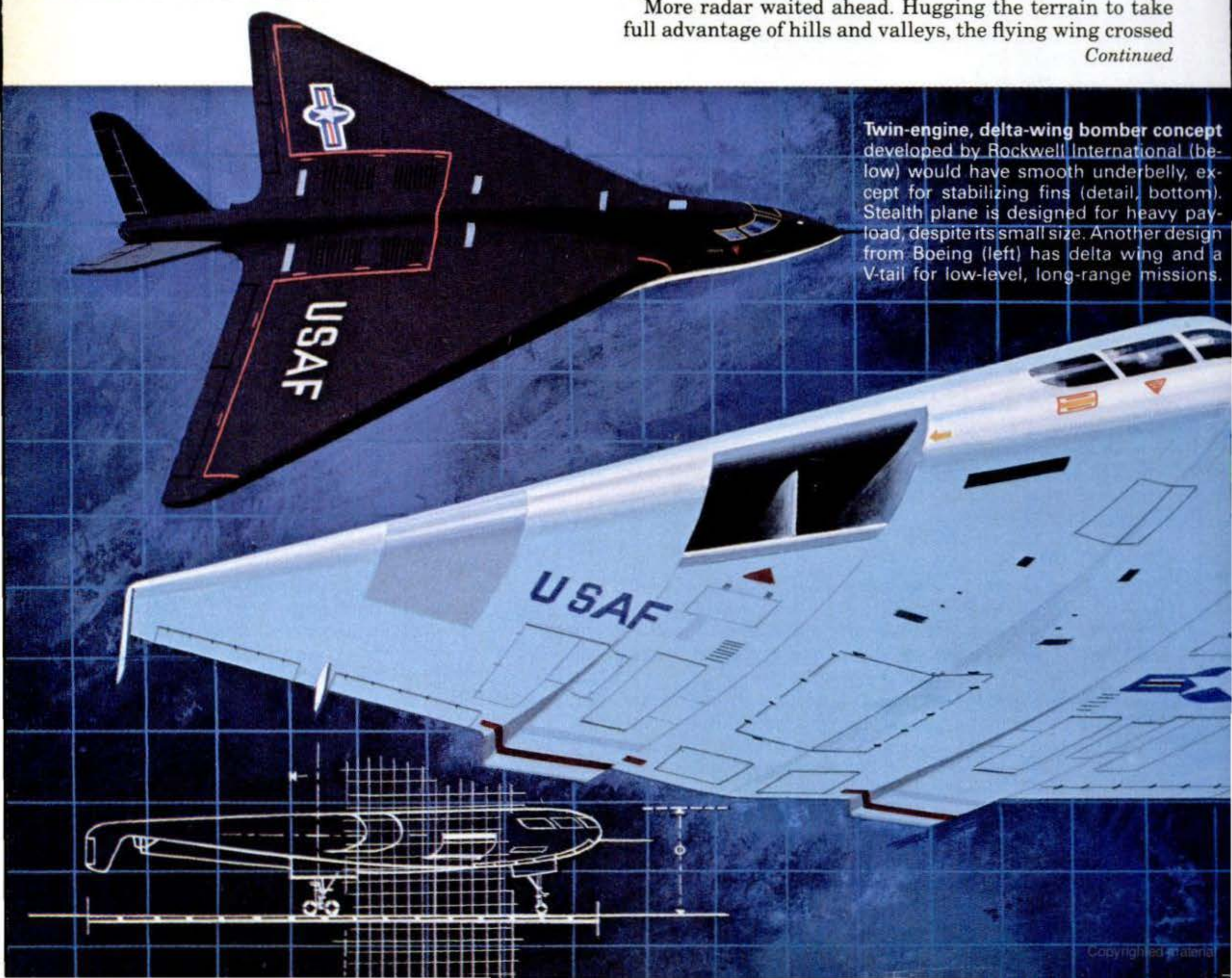

Twin-engine, delta-wing bomber concept developed by Rockwell International (below) would have smooth underbelly, except for stabilizing fins (detail, bottom). Stealth plane is designed for heavy payload, despite its small size. Another design from Boeing (left) has delta wing and a V-tail for low-level, long-range missions.

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SR-71 Blackbird spy plane (left) is one of the earliest designs with anti-radar stealth concepts. A blue-black coating is thought to have radar-absorbing properties. The engines blend smoothly with the wings, and slanted tail fins minimize radar reflections. British Vulcan bomber (above) also has stealth features: Engines are concealed within its triangular wing, unlike engines on B-52s, which capture and reflect radar signals.

Aerodynamic efficiency boosted in another Boeing design that trades off some rad and infrared invisibility for bet ter engine performance. Desi stresses long-range capabili

Angled engine inlets (detail) are shrouded to cut radar reflections in this Boeing concept. Engine outlets are designed to reduce heat visibility from below.

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Lear Fan 2100 prototype, made largely with graphite composites, is a commercial aircraft design that's almost invisible to radar.

out of the tundra. Despite its size and speed, it created just a flicker on glowing scopes. It was no more than a hummingbird darting south.

But this bird, still a paper airplane that won't fly before 1987, will be no harmless little avian. The popular word used to describe it masks the most secret U.S. technology program in four decades:

Stealth.

This multi-billion-dollar development, already under way in a classified and guarded Northrup Corp. facility midway between two major Los Angeles freeways, is aimed at producing a new bomber that is virtually undetectable by radar. A secondary effort to produce a modified B-1 bomber with a low radar profile is under way at a Rockwell International plant in nearby Palmdale.

And a third project, by the Lockheed Corp., already has produced at least three prototype stealth fighters. Flying from a secret field near Groom Lake, Nev., and from Eielson AFB, Alaska, since 1979, two of these triangular-shape craft have crashed, but for reasons not connected to their strange design. The third reportedly continues to fly test missions in both extreme heat and cold.

Taken together, the Pentagon expects these futuristic aircraft to alter the balance of military power into the next century.

How will a bomber-size aircraft deceive radar that is itself state of the art? What new technology is on the drawing board to create a machine that will penetrate enemy airspace with impunity?

Some answers are emerging from this highly classified program. Others undoubtedly will remain among the nation's most tightly kept secrets. Briefings on stealth technology, when authorized by the Air Force, are sketchy. Even individuals allowed to talk insist that their names be concealed.

Even so, it was possible to put together a filtered look at how the best aeronautical engineers in the world are designing stealth-type aircraft. Some of the picture, necessarily, is informed speculation by experts. But much already is known.

Low-flying attack

The bomber, for instance, is being designed to fly intercontinental distances at low altitudes at about Mach 0.85. "High-altitude attack is not a wise idea because it gives the enemy a longer time to look at you on the way in," one observer said.

The Air Force itself discourages the word "stealth." It prefers the term "low observable" and calls Northrup's project the ATB, or advanced-technology bomber.

"When you talk about stealth," a high-ranking Air Force officer told me, "you're talking about the ability to offset the enemy threat to your penetration."

To do that takes an aircraft with a unique shape, built with materials and coatings that both absorb and deflect radar signals. It takes innovative designs to conceal jet engines within the aircraft body. And it takes a host of new electronics gear aboard the craft to isolate and confuse enemy radar.

But the first step is designing the aircraft itself. Air Force and industry officials stress that reducing radar cross section—the reflecting surface actually seen by radar—is the major factor in playing aerial hide-and-seek. Cross section is measured in square meters, as seen head-on by defense radars.

For instance, the ancient B-52 that remains our primary intercontinental bomber has a massive radar cross section of about 100 square meters. Its tall, vertical stabilizer and heavy body make it an ideal radar target. Even worse, its large wing-slung engine pods concentrate radar signals and echo them back with brilliant clarity.

A shrinking target

Rockwell's original B-1, which Jimmy Carter refused to build, produced a radar image of just 10 square meters. And the B-1B, now being reworked in a stealth version that will fly in 1985, echoes a cross section of just a single square meter.

That's a flashing alarm compared with the stealthy bomber on Northrup's drawing boards. It reportedly will have a radar cross section of one-millionth of a square meter. A hummingbird is bigger.

Designers will achieve this strikingly small radar cross section with a number of design innovations. For example, sharp edges and abrupt angles, often seen on aircraft wings and control surfaces, produce strong radar echoes. So there will be none on the new planes. Northrup's bomber will be a low-profile flying wing. (Significantly, Northrup also built the original B-49 Flying Wing, which first flew in 1947.) Tomorrow's stealth bomber will take the concept even further, expanding on the so-called blended-body concept provided by Rockwell's B-1 [PS, May '77]. Its wing-body leading edge will be smoothly rounded, and its delta shape will integrate fuselage, cockpit, and wing into a single flowing wedge. Engines will be buried inside the body, not hung out as tempting radar targets.

Northrup engineers also are wrestling with designs for the vertical stabilizer. Their first choice is to eliminate it completely. If computer analyses point up handling problems with that concept, Northrup may decide to use small

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twin stabilizers. They would be canted inward to deflect radar rather than echo it.

No information is available about overall size of this flying wing. But it is certain to be low-slung and squat, almost like a Frisbee or boomerang in proportions. All that will make radar sighting more difficult. Yet more is needed.

One solution is to eliminate metal wherever possible. Early versions of radar-absorbing materials, primarily carbon-and-fiberglass composites, were developed by Rockwell for the Hound Dog missile. That technology is being adapted for the stealth bomber.

Recent advances by a number of laboratories, including the Air Force Materials Laboratory at Wright Patterson AFB, Ohio, have led to composite materials that are stronger and lighter than steel or titanium yet do not reflect radar waves. A black fiber-reinforced graphite skin is reported to be the leading contender for Northrup's bomber.

With current technology, materials that absorb some electromagnetic radiation are bonded to stronger titanium. But Lockheed's super-secret stealth fighter is believed to be made largely of Fibaloy, a composite developed by Dow Chemical Co. Fibaloy includes glass fibers embedded in plastic and is said to be strong enough without metal backing to form both the fighter's skin and its main structural members.

The result is a 20,000-pound fighter not only stealthy, but small and light enough to be carried inside a C-5A transport.

And the Air Force is heavily committed to developing even better carbon composites. That leaves the stealth-bomber designers to consider their jet engines, which can't eliminate metal.

> "With front-facing air intakes, that metal echoes radar like a beacon. But the new bomber will have concealed intakes, mounted flush beneath the flying wing"

"Jet-engine intakes are high-visibility items for radar," one aeronautical expert told me. "To get enough air into an engine, you need big compressor sections up front. They're very balanced, built to close tolerances, and made of heavy metal."

With front-facing air intakes, that metal echoes radar like a beacon. But the new bomber will have concealed intakes, mounted flush beneath the flying wing. It also may employ a version of a new intake-tunnel configuration being developed for Rockwell's B-1B.

Called the zigzag tunnel, this innovation eliminates the straight-line air flow that also lets radar flash directly into the engine compressor. The new tunnel has twin channels with a series of carefully designed curves that minimizes radar reflections.

The expandable throat needed to reduce incoming air speed and prevent a compressor stall in a high-flying supersonic aircraft is gone. The result is a radar fooler. Signals entering the zigzag tunnel reflect back and forth at the curves, instead of echoing a bright reflection to a radarscope.

"We can do it because the B-1B is now a subsonic, low-altitude penetrator," an Air Force officer said. "There's no problem with stalls."

The new flying wing will add another innovation. Its jet-engine exhaust will be cooled and masked, exiting from smoothly faired thrust vents at the trailing edge. That won't affect radar but will help protect the stealth bomber from heat-seeking missiles or detection by infrared sensors.

Northrup's stealth aircraft also will benefit from radar-absorbing coatings first developed for Lockheed's legendary SR-71 Blackbird. That plane got its name from the inky-black coating that reduces its radar signature and camouflages it against the dark sky.

Details on newer coatings are highly classified. But Northrup is said to be including that technology in its flying wing.

B-1B accessories

Avionics will make up the rest of the fighter's approach to radar invisibility. While declining to discuss the electronics that will go into the flying wing, the Air Force provided some details on equipment for the low-observable B-1B.

First, the dish-type radar antenna in the nose of the craft is gone, replaced by a phased-array antenna that resembles a flat, oval plate. "The dish became a radar target itself in some instances," an Air Force official said.

The phased-array antenna never moves. It is angled generally forward, but its radiation is aimed electronically, and it doesn't reflect enemy signals. The system was adapted off the shelf from a radar employed in the F-16 fighter.

The Air Force and Rockwell also eliminated an antenna that ran down the B-1's back like a visible spine. That spine provided angles just made to echo radar. The antenna, part of a programmable defensive-avionics system, will be built directly into the aircraft.

The system is computer controlled and on-board programmable to seek and identify enemy radar or missiles. "These avionics are the current state of the art," the officer said. "They've been tested against surrogate Soviet systems and will defeat anything currently in their radar-antenna inventory and any upcoming threats," he confidently asserted.

The system being developed for Northrup's stealth plane is presumably even better.

"Radar cross section is only one aspect that's going to make a super-penetrator," the officer said. "The other half is the avionics. When you get the radar visibility down very small, you can start manipulating the radar signals so the enemy doesn't see you."

That means stealth-type aircraft will carry new electronic-countermeasure gear to identify a radar station, then transmit just the right signal to erase even the hummingbird speck from its scope. The kind of countermeasure equipment now in use must be powerful enough to obliterate the large radar signatures current aircraft produce. Still, radar operators frequently know something is happening, though maybe not what, when their scopes are jammed.

"If you can use just enough energy to foil each radar set, they won't even know you're there," the officer explained.

If current funding levels continue, the B-1B will be operational in 1986, with 100 of them flying by 1988. To protect against it, the Russians will have to spend five times as much on defenses as the aircraft cost the U.S., according to an Air Force source. And that's just the start. The Northrup stealth plane now is scheduled to be in the military inventory by 1992. "That will take another five-fold expenditure if they want to even think about stopping it," the officer said. PS

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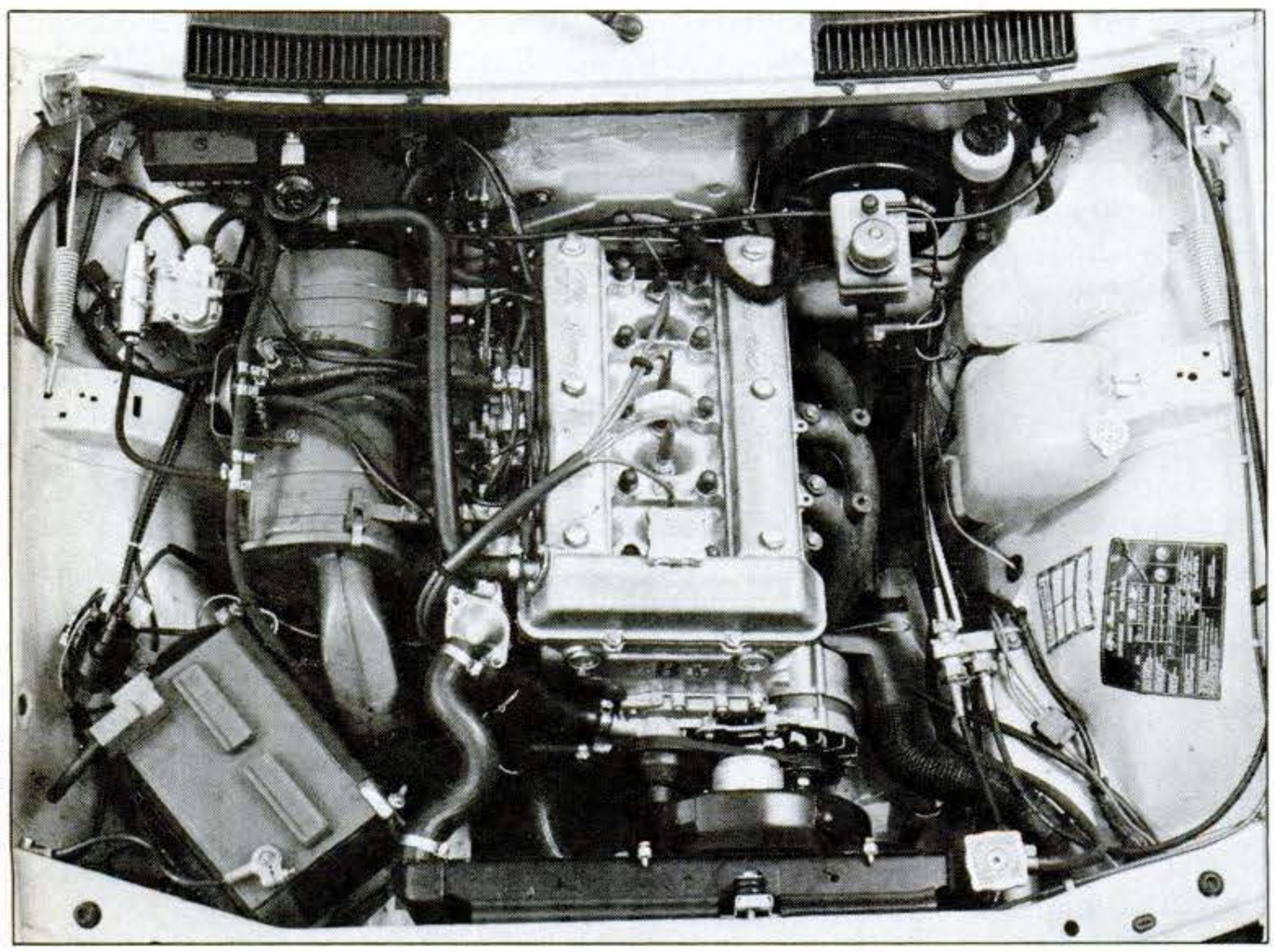
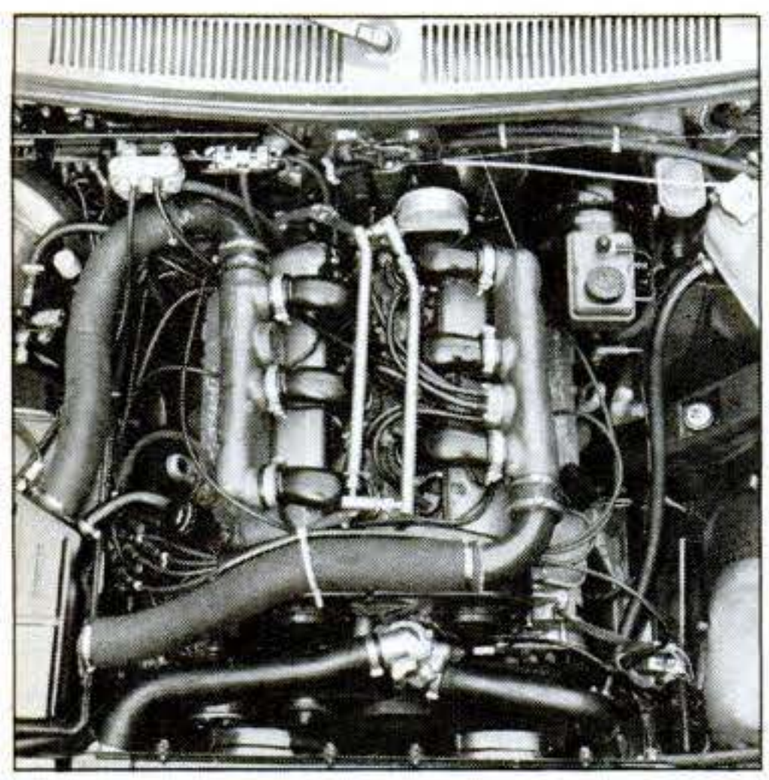
Modular engines

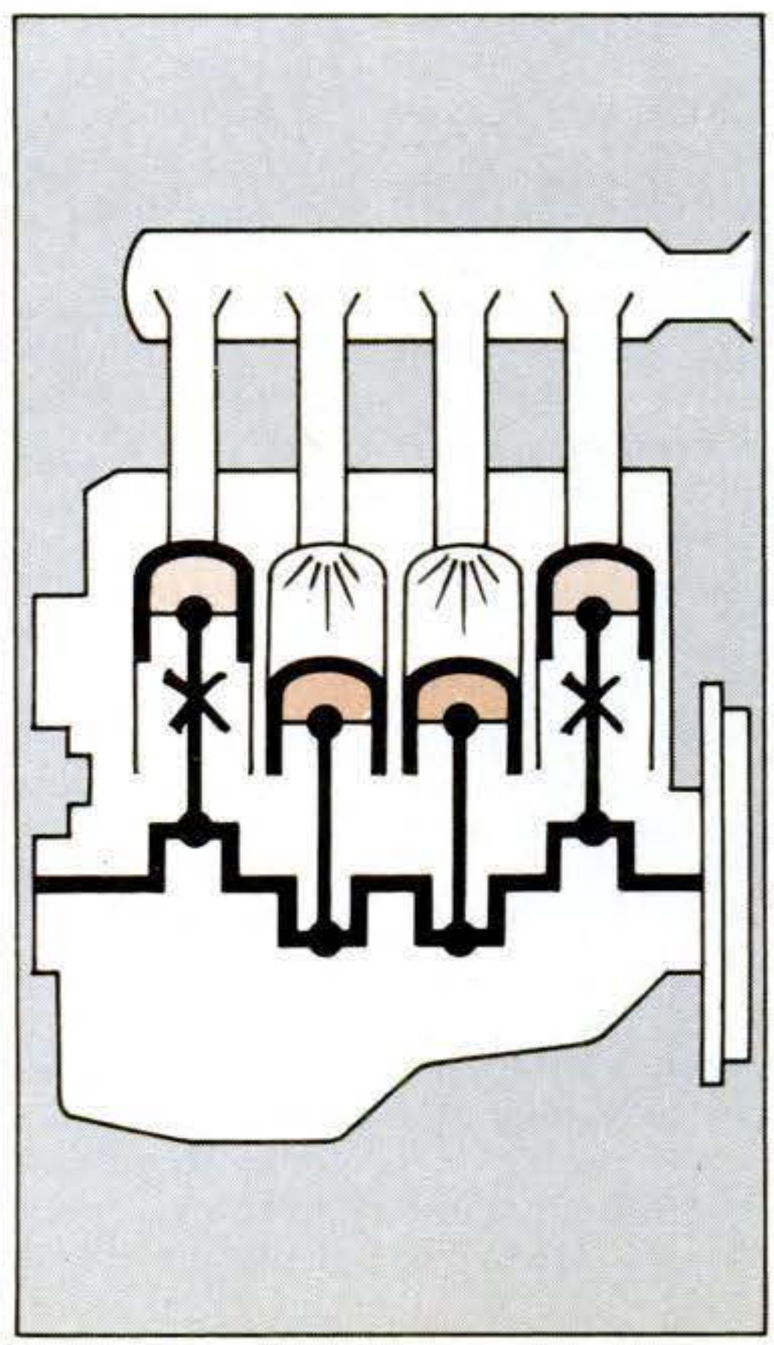
accelerate on all cylinders; cruise and idle on half

From Italy: new variable-displacement engines that improve mpg up to 24%

By HERBERT SHULDINER







Four-cylinder modular engine (top) starts on all cylinders. When engine coolant warms to 70 deg. C, two cylinders cut out (see drawing). The system is designed to alternate cylinders (1 and 4, 2 and 3) every 200 cycles. This maintains thermal efficiency of the cylinders. To get full power from all four cylinders, you merely floor the accelerator. The cycling of the cylinders is barely perceptible to the driver. Six-cylinder modular engine (above) alternates banks of three cylinders.

MILAN, ITALY

Imagine cruising on two cylinders in a 2,500-pound car at 60 mph and not feeling underpowered. That's the way it felt in a modular-engine-equipped prototype Alfa Romeo Alfetta I drove recently at the company's test track on the outskirts of this city.

The Alfetta was powered by an electronically controlled four-cylinder, two-liter (122 cu. in.) engine that uses only half its cylinders when the car reaches cruising speed. But when you floor the accelerator, you get the full power of all four cylinders for fast getaways or passing. And it all happens automatically; a computer makes the decisions. The result is up to 24 percent better fuel economy than that of the same car without the variable-displacement engine, Alfa claims. The car will be in production by the time this issue reaches newsstands.

"We intend to build 1,000 Alfettas with modular engines in the 1983-model year," says Filippo Surace, Alfa's chief of research and development.

Why should this car succeed when GM's variable-displacement Cadillac [PS, Oct. '80] was prone to an epidemic of mechanical and electronic failures? "Our electronics make it better than the GM system," Surace claims. Alfa uses an eight-bit microprocessor that sifts inputs from sensors monitoring throttle angle, engine speed, engine phase, and water and intake-air temperatures. Based on this information, the microprocessor controls four electro-injectors to meter fuel, an electronic control coil for ignition advance, and a throttle actuator to control engine idling speed.

The modular engine always starts on all four cylinders, but when the coolant warms to 70 degrees C (158 F), two cylinders cut out in idle mode. Thereafter, it idles on two cylinders unless engine speed falls below 680 rpm. (See drawing and caption at left for how engine operates under cruising conditions.)

Surace says Alfa is working on a six-cylinder version of the modular engine. This engine will run on three cylinders, he says, except when additional power is required.

Surace says introduction of cars with modular engines into the U.S. may not occur—if ever—until one or two years after the Italian market gets the cars. PS

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World's fastest laser

stops the action at the quantum limit

In the realm of the femtosecond: Bell Laboratories' Charles Shank adjusts laser elements (top) while colleague Richard Fork watches spectrally broadened pulse emerge from optical fiber.

Ultrashort pulses shine the first light on some long-standing uncertainties

By STEVE KINDEL
ILLUSTRATION BY RAY PIOCH

The sign on the door of the fourth-floor lab is a cautionary "Laser Experiment in Progress—Do Not Enter," and the window up near the top of the door glows cherry red. Inside, Dr. Richard Fork, a Bell Laboratories physicist, works with an assistant, who sits behind a protective wall logging data as it comes up on an oscilloscope screen.

"Whatever you do, don't look at the laser," Fork warns. But even looking away, its pulsing, flickering stabs of light cascade off my retina. The effect is hypnotic and finally slightly nauseating. Fork is sympathetic; such side effects bother many of the people who visit the lab for the first time.

What brings people around is a stunning scientific achievement. Fork and Charles Shank, who heads Bell's quantum physics and electronics department, have managed to generate pulses of laser light just 30 femtoseconds in duration. That's fast: A femtosecond is a quadrillionth of a second. But Shank has a much more graphic way of conveying just how fast that is. "In a second," he says, "a

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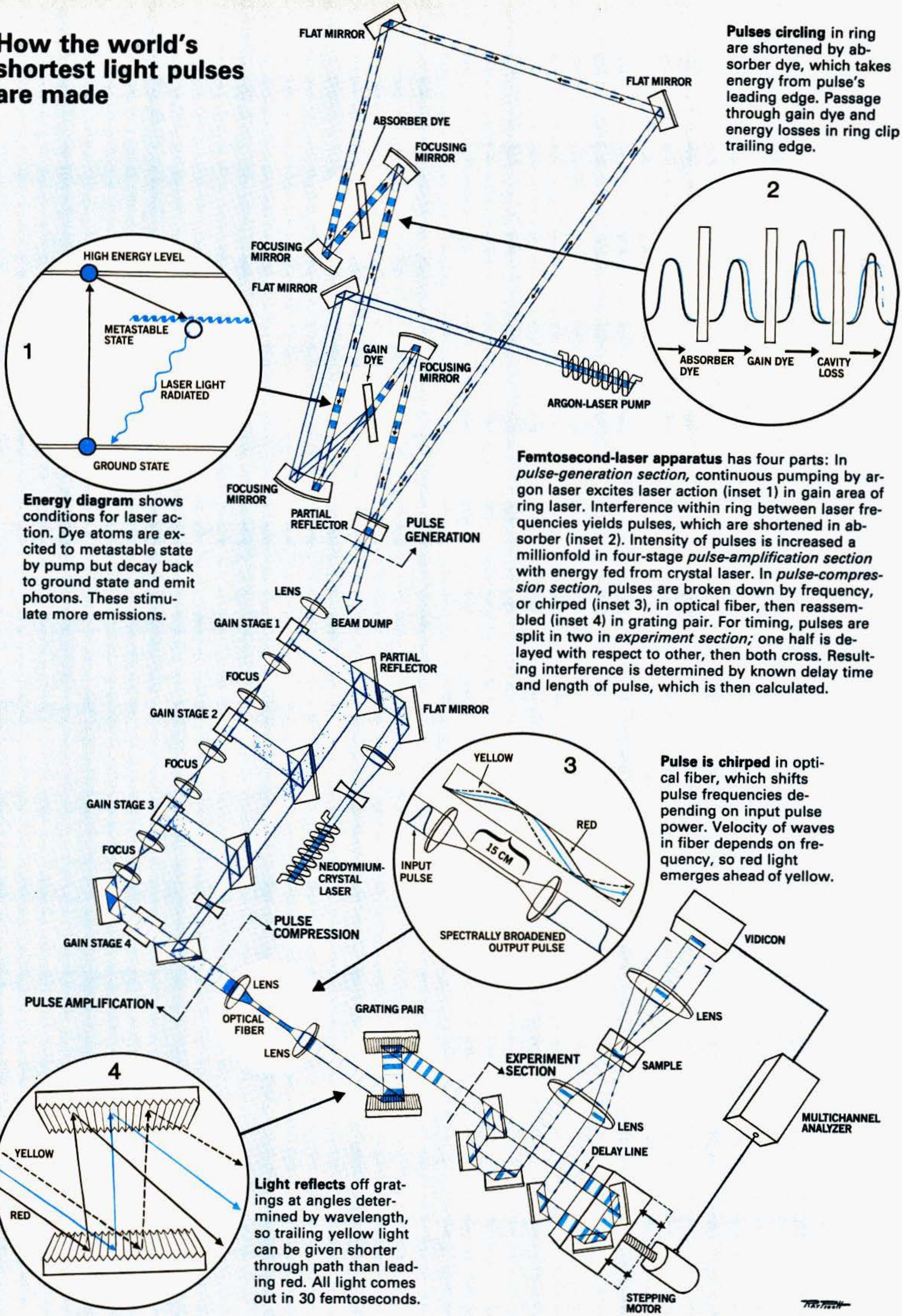
How the world's shortest light pulses are made



Pulses circling in ring are shortened by absorber dye, which takes energy from pulse's leading edge. Passage through gain dye and energy losses in ring clip trailing edge.

Energy diagram shows conditions for laser action. Dye atoms are excited to metastable state by pump but decay back to ground state and emit photons. These stimulate more emissions.

Femtosecond-laser apparatus has four parts: In *pulse-generation section,* continuous pumping by argon laser excites laser action (inset 1) in gain area of ring laser. Interference within ring between laser frequencies yields pulses, which are shortened in absorber (inset 2). Intensity of pulses is increased a millionfold in four-stage *pulse-amplification section* with energy fed from crystal laser. In *pulse-compression section,* pulses are broken down by frequency, or chirped (inset 3), in optical fiber, then reassembled (inset 4) in grating pair. For timing, pulses are split in two in *experiment section;* one half is delayed with respect to other, then both cross. Resulting interference is determined by known delay time and length of pulse, which is then calculated.

Pulse is chirped in optical fiber, which shifts pulse frequencies depending on input pulse power. Velocity of waves in fiber depends on frequency, so red light emerges ahead of yellow.

Light reflects off gratings at angles determined by wavelength, so trailing yellow light can be given shorter through path than leading red. All light comes out in 30 femtoseconds.

pulse of light can travel almost to the moon, but in 30 femtoseconds light travels only about one-tenth the thickness of a human hair."

Scientists need such fleeting pulses to investigate phenomena that occur at ultra-fast speeds—beyond the resolving power of conventional electronic measuring devices. These phenomena include many of the most fundamental processes of physics, chemistry, and biology: atomic collisions and vibrations, intermolecular chemical reactions, photosynthesis mechanisms, and more. In the realm of time and space in which these processes occur, matter does not always behave with the billiard-ball predictability of everyday experience. To account for the uncertainties, science has found it useful to describe such events as statistical probabilities. But Bell's femtosecond laser, by coherently stimulating such processes in sample materials and then measuring changes in the samples' optical properties, can actually catch nature at its quantum tricks.

Order-of-magnitude jumps

The possibilities for such a diagnostic tool are momentous—and not just in pure research. Discoveries about the behavior of light and matter are likely to have an important impact on such practical technologies as microelectronics and communications. This is why Shank tells visitors that his team's "primary motivation is not to generate the shortest pulses but to venture into the unexplored."

Still, getting there must have been half the fun. The quest for short pulses began only a few years after the development of the first optical oscillator, or laser. Since 1966, pulse duration has dropped steadily from the realm of the nano- (billionth) to the pico- (trillionth) and now finally to the femto-second. Each new shortening required development of a new technique, so in a real sense progress has moved along more by inspiration than perspiration. Much of that inspiration has struck at Bell's Holmdel, N.J., labs, where I went recently to get the story.

To my unschooled eye, the array of lenses, mirrors, and gratings arranged on the long, flat table in Fork's lab looked like other laser configurations I'd seen. In fact, I was looking at a series of lasers: a very special ringed-cavity dye laser powered by a commercial gas laser and coupled to a sophisticated crystal-laser amplifier. Fork explained that although it had earlier antecedents, the device's direct lineage goes back to a machine operated by Shank and Erich Ippen in 1972. It was one of the first lasers to produce pulses by a process called mode locking. All lasers resonate at many modes, different multiples of a fundamental frequency. In lasers designed to produce frequency-pure light, great pains are taken to remove the surplus modes, but in others the modes are locked in step to generate interference patterns that result in a pulsed, not continuous, output. The more modes at which a laser oscillates, the shorter the pulses. Organic dyes are chosen as the lasing medium in mode-locked lasers because they oscillate at many modes. Bell's 1972 device was also the first pulsed laser to be powered—pumped—not by intermittent bursts from a flash lamp but by light from another, continuously operating laser. Thus, it not only produced record-setting short pulses—1.5 picoseconds—but these pulses were the first with near-perfect reproducibility and high repetition rates.

To reach where they are today, the Bell group revised that original device several times, then tacked on a pulse-shortening scheme borrowed from radar technology. The first series of improvements involved passing the pulses through a second channel of dye, not to contribute laser light as the principle (gain) dye does but to selectively absorb the leading and trailing edges of the pulses. With that they reached 0.3 picoseconds. Then they assembled the laser components in a ring so the pulses travel simultaneously around the ring in opposite directions and collide in the absorber. The coherent pulses interfere and set up a standing-wave pattern that forces each pulse into the same precise shape.

The shortest pulses are produced, Fork told me, when the absorbing region is no wider than the desired pulse width. In addition, because the dye is able to absorb just a small amount of energy before saturating, it must continuously be replaced. Therefore, for pulses in the femtosecond realm, a flowing stream of absorber dye just thousandths of a centimeter across was needed. That required fabrication of fantastically small metal nozzles. "The problem," Shank said, "is how to shape the nozzle as you draw it down. If it's the wrong shape, you just spray dye all over the place." The team's technician, Fred Beisser, finally managed to get about one nozzle in 10 to work well. "When you're working at the limits of a technology," Shank added, "everything is kind of flaky, and success is defined as something that works on a regular basis."

The colliding-pulse mode-locked laser, completed in 1980, worked on a regular basis, producing pulses just 65 femtoseconds long, though when amplified in a four-stage laser to increase pulse power from thousands to billions of watts, the pulses broadened to 90 femtoseconds.

The final compression was accomplished by adapting a pulse-compression technique used in radar for 30 years. It's a two-step process of first breaking the single-color pulse down into a spread of frequencies, then using the characteristic diffraction angles of the different frequencies to reassemble the pulse (see illustration). The result, as demonstrated early last summer, is a 30-femtosecond pulse of white light.

Are even faster pulses possible? Yes, puns Fork: "The barriers are more fiscal than physical." But 30 femtoseconds corresponds to only 14 cycles of light. It is clear the Bell team is fast approaching fundamental limits.

The other half of the fun

Although there was a strong virtuoso component to the development of the femtosecond laser, the scientists insist it is merely a tool for probing the unknown. The experimental technique is to split each pulse into two parts: a powerful pump pulse and a weaker probe pulse. The pump excites the desired process in a sample, which changes the way the sample interacts with the slightly delayed probe. Optical analysis of the probe after it emerges tells the experimenter about conditions in the excited sample.

This technique will be used by researchers in many different fields, but Shank's and Fork's prime interest is observing the behavior of electrons as they move through semiconductor materials. They have already had great success in understanding a phenomenon called "velocity overshoot." Fork explains: "There are in a semiconductor structure what we call momentum valleys, areas where the effective mass of the electron is one-tenth its normal mass and where it moves at a much faster rate than usual. When it acquires enough momentum, it spills out of this valley and bumps into the semiconductor lattice. When that happens, the lattice vibrates and a bit of energy called a phonon is emitted while the electron scatters in some random direction."

The femtosecond laser has allowed Shank and Fork to observe this process for the first time. Further research could lead to the design of semiconductor devices with lattice structures that eliminate scattering. Such a new family of semiconductors might, in turn, herald a new generation of high-speed computers. But such direct payoffs are still some distance down the road. Others aren't even anticipated. Predicts Shank: "The most important result of the femtosecond laser will be the discovery of phenomena not presently contemplated."

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What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS

Spear gun

The Gunslinger spear gun straps to your thigh for hands-free diving. The 18-in.-long, band-powered weapon extends to a 36-in. double-sling format when needed. Price: $140. SeaAir Products, 350 N. Lantana Ave., No. 505, Camarillo, Calif. 93010.

Four-wheel ATV

Four wheels on the LT125 4×6 all-terrain vehicle give you performance three-wheelers can't: The extra front wheel aids stability and soaks up bumps, says Suzuki. The LT125 has a 125-cc (7.6 cu. in.) engine and five speeds plus reverse.

Maneuver flaps

Pairs of underwing flaps on Dornier's Alpha Jet enable it to fly sideways and turn without banking. The German research aircraft can fix on targets and evade enemy fire faster. Opening all the flaps at once points the plane down without building up speed.

Teflon grease

Power tools, engines, fishing gear, guns, vehicles—these are just a few of the applications for Magnalube-G, a Teflon-base all-purpose grease, says Carleton-Stuart Corp. (13-02 44th Ave., Long Island City, N.Y. 11101). Minute Teflon-resin particles are mixed with petroleum lube.

Mine hunter

Pinquin B3, a remotely piloted undersea craft, is directed to a target area then guided automatically to mine-like objects. The unmanned craft, developed by Germany's MBB/VFW, can identify an object, drop a disposal charge if necessary, and proceed to a new target.

European spinoff

Classy styling and lots of space: That was Pininfarina's goal for its Gamma Olgiata, a study-model vehicle derived from the Lancia Gamma coupe. Aside from the rear third door, the front-wheel-drive European car looks much like other Lancia coupe spinoffs.

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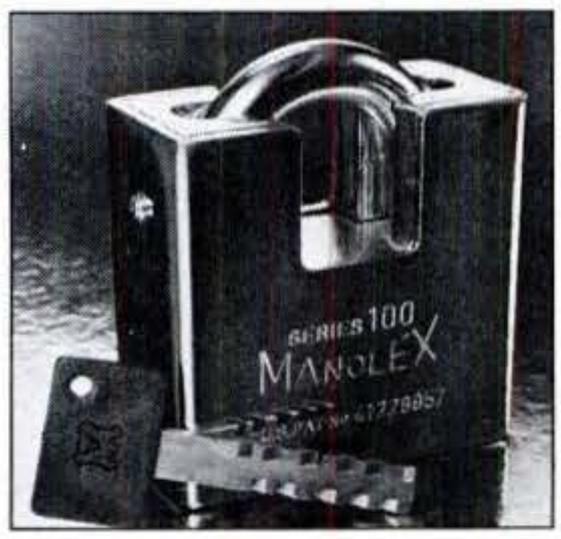
Anti-mine chopper

Huge side tanks hold 1,000 gallons of fuel on the U.S. Navy's Super Stallion copter. Flying ahead of ships to search for mines, it can remain on station for four hours. Three turbine engines and the seven-blade rotor can lift almost 35 tons. It's slated for mid-1980s introduction.

Helmet holder

Carry an extra helmet for motorcycle passengers? The Helmet Bra from Eclipse, Inc. (Box 7370, Ann Arbor, Mich. 48107), holds any full-face or open-face helmet with a seat strap. Velcro on both sides of the mesh fabric enables the holder to adjust to many sizes. Price: $10.



Super-lock

A hardened-steel alloy for its one-piece body and shackle makes Manolex 100 a high-security padlock. But its drill-proof locking device, plus a key that can't be duplicated by impression, means extra security, says Hudson Security Products, 475 Fifth Ave., New York, N.Y. 10017. $58.

Low-drag import

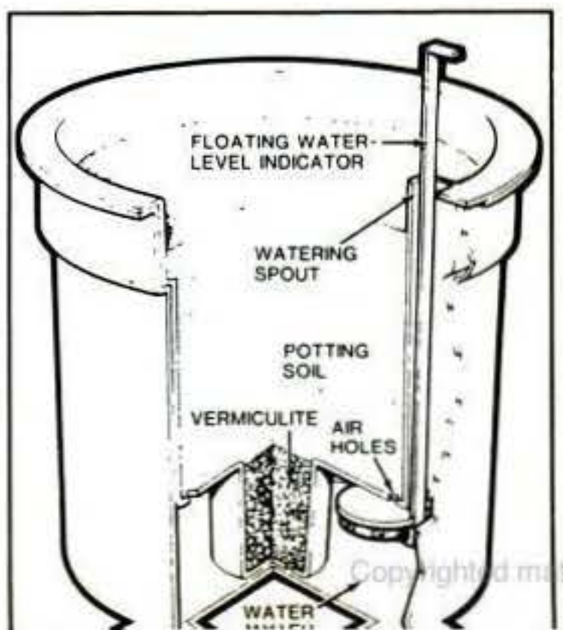
Lowest drag coefficient of any production car—0.30—is claimed by Audi 100 makers. The ultra-slippery car, 65 lbs. lighter than the previous model, has integrated headlights and nearly flush side windows. It will be introduced here this spring as the Audi 5000.

Computer chair

Spend lots of time at a computer CRT terminal? Charvoz Dauphin's CRT Chair G1500 features a lumbar-comfort back plus pneumatic levers for height and back incline. It's designed in Italy, engineered in Germany. Charvoz-Carse, 5 Daniel Rd. E., Fairfield, N.J. 07006.

Reservoir planter

Move plants into Genie planters and water once every 21 to 30 days, says the manufacturer. An indicator shows when the reservoir is low. Capillary action draws water through the vermiculite. Hydro-Planter Designs, 5510 Ambler Dr., Mississauga, Ont. L4W 2V1. $4 to $13.



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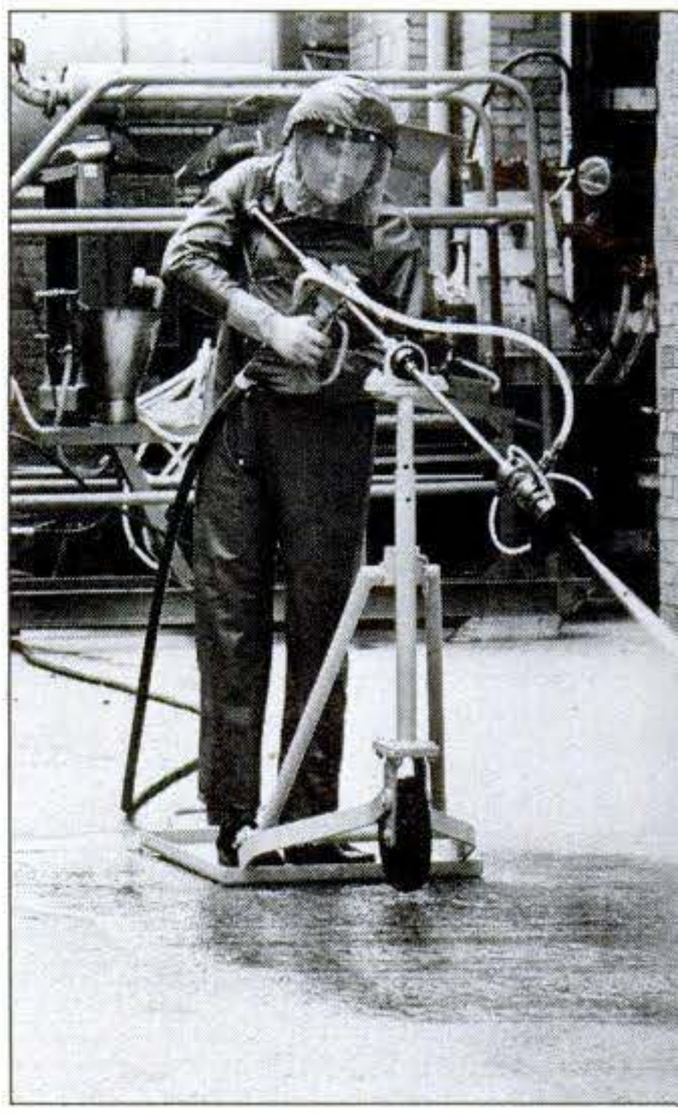
What's New

Gallic go-getter

This chunky-looking Citroën has a low drag coefficient of 0.33 and a 2,000-lb. curb weight. Its 1,580-cc (96 cu. in.) engine gives the front-drive BX a top speed of 109 mph and zero-to-60-mph acceleration time of 11.5 seconds. It's not available in the U.S.

Double delta

A big delta-shape canard lets the Saab JA 37 Viggen make extra-tight turns as it fires its high-powered, 30-mm cannon. The Swedish fighter also carries six air-to-air guided missiles plus an extra, throwaway fuel tank. The STOL plane can use highways as runways.



Water jet

Pressurized at 50,000 psi and mixed with abrasives, water shoots from the nozzle of this rifle-like gun. The jet slices smoothly through steel, rock, and masonry, claims the developer (BHRA, Cranfield, Bedford MK3 0AJ, England). The tool is said to be quicker than flame cutters.

Compact-car rack

Car-top bikes without blocking the hatch: Solorack bolts onto most cars with 26-in.-long rain gutters. The rack converts to a ski or boat rack and carries loads up to 250 lbs., says Freeman Industries (1224 Robbia Dr., Sunnyvale, Calif. 94087). $145.90.

Flexible fiberglass

Framed in fiberglass, this low-cost plastic greenhouse features Polystal, an advanced composite with all fibers oriented in the same direction. The slim shafts can be bent like fishing rods yet can carry high loads, says Bayer AG, 5090 Leverkusen, Germany.

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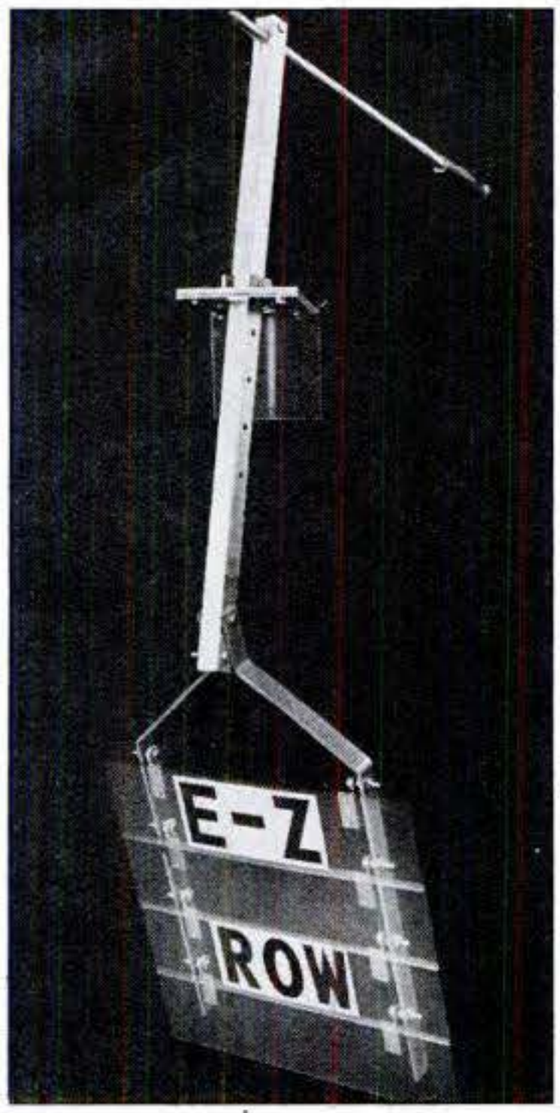
What's New IN BOATING

BY SUSAN RENNER-SMITH

Smart sounder

The microprocessor-controlled Tracker 2000 chirps in three tones, alerting you to the presence of fish, depth changes, and dangerous shallows. A unique vertical depth scale with four ranges marks both bottom and fish depth. The OMC instrument costs $399.50.



Rowboat paddle

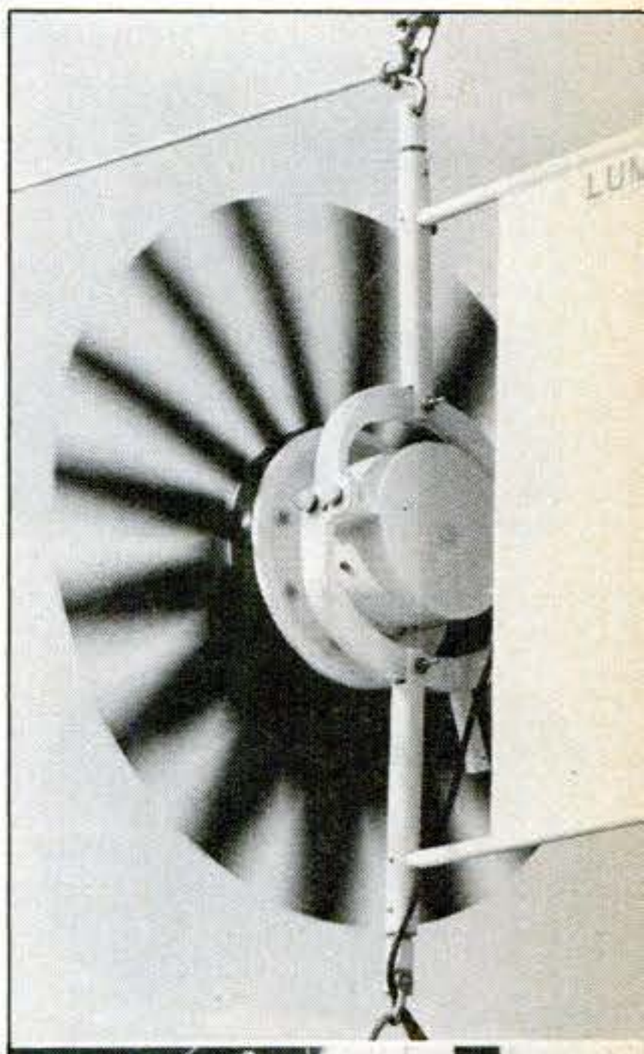
You can scull and steer one-handed with the E-Z Row. Clamp the adjustable mounting bracket to a dinghy's stern and pump the handle: Four Lexan fins open and close, propelling you as fast as oars, claims Western Custom Service (Box 96, Socorro, N.M. 87801). $79.50.

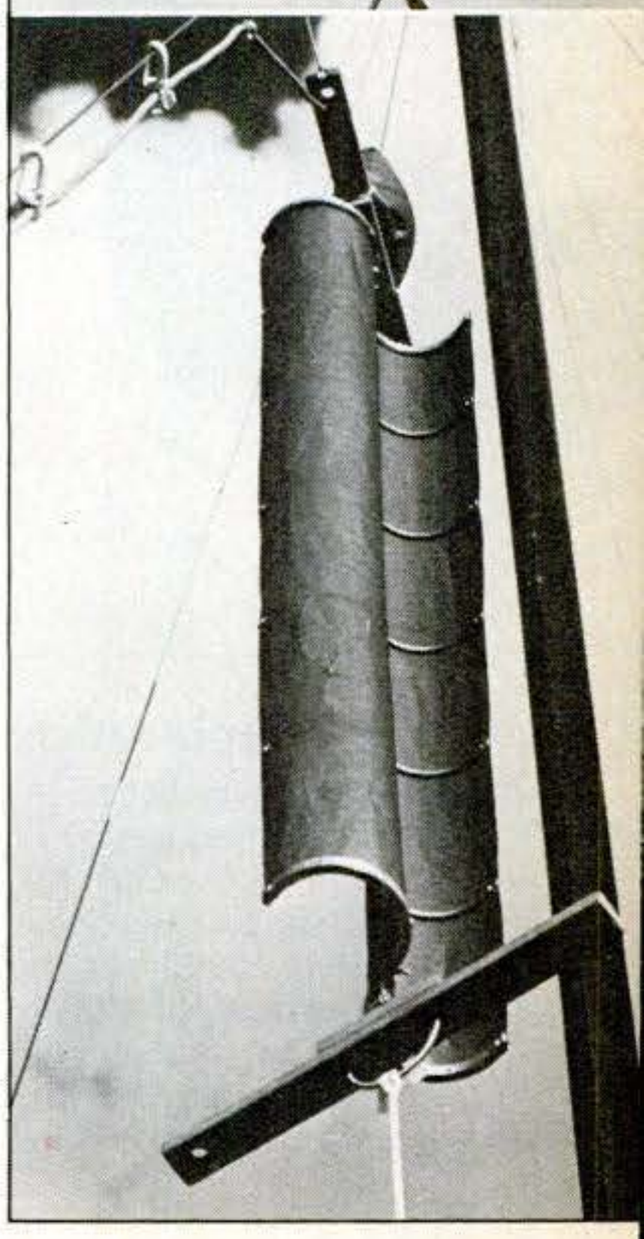
Wishbone cat-ketch

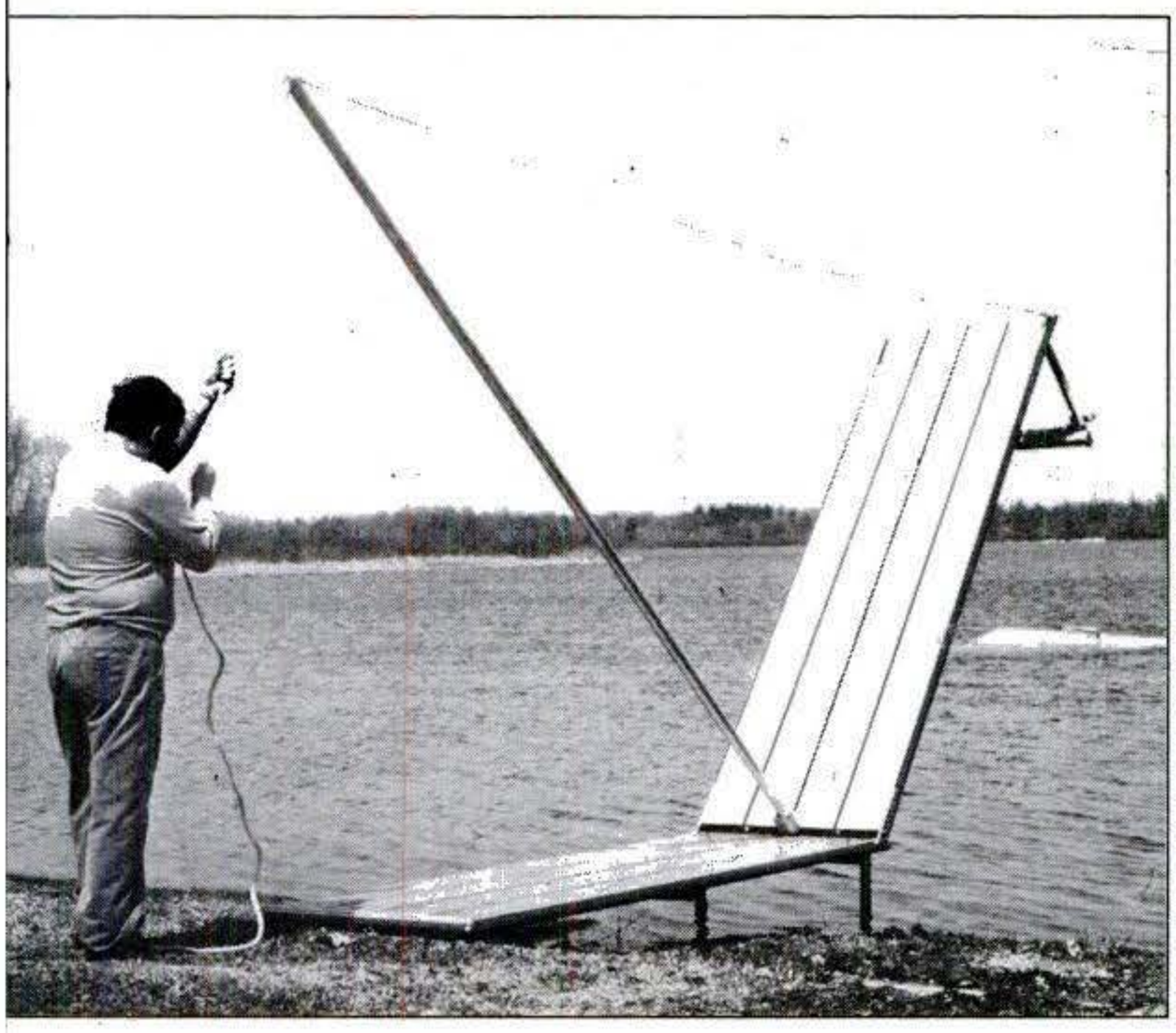
With unstayed masts and wishbone booms, Wings 33 outperforms most same-size cruising craft, says Offshore Yachts (Box 6, Cos Cob, Conn. 06807). Why? There are no drag-causing shrouds, and the booms provide optimal sail shape. Sail-away cost: $52,995.

Two windchargers

Suspended from the jib halyard, the Altair 50 (right, top) can generate 50 watts of electricity for a sailboat at anchor. In wind speeds of 20 knots, the charger provides two amps of current. The 26-in.-dia. turbine has 14 replaceable polypropylene blades. With rear-mounted alternator, the unit weighs 21 lbs. It's $695 from Jack Rabbit Marine (Box 595, Larchmont, N.Y. 10538). The Wattknot (right) has a sailcloth rotor supported by aluminum battens. The seven-lb. unit with top-mounted 30-W generator hangs below the spreader, generating one amp in 20-knot winds. $295 from Altech (724 Euclid Ave., Toronto, Ont. M6G 2T9).







Dry dock

The dock gets wet, of course, but you don't. A simple rope-and-pole hookup lets you stand on the shore as you lower aluminum sections into the lake. Removing the dock is also easy, says Instant Marine (1111 S. Woodward, Royal Oak, Mich. 48067). $508 per 10-ft. section.

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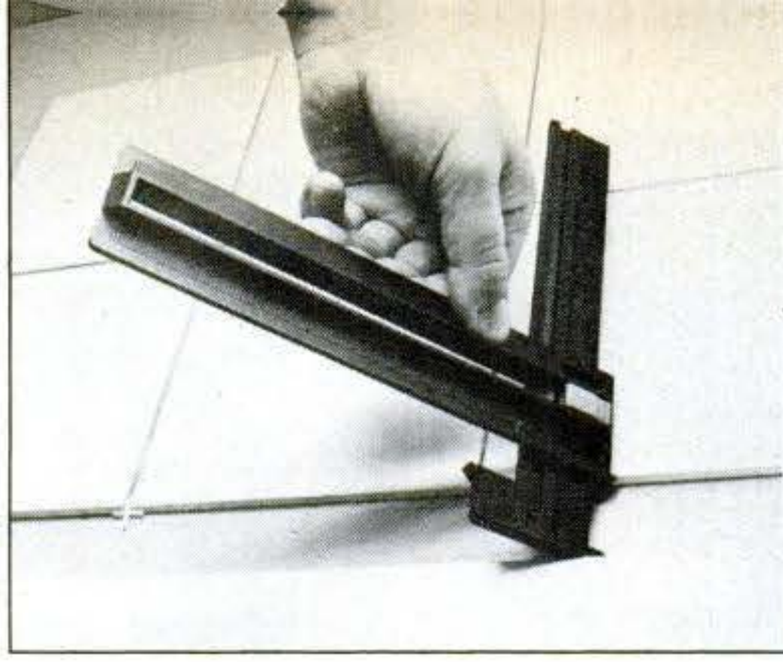
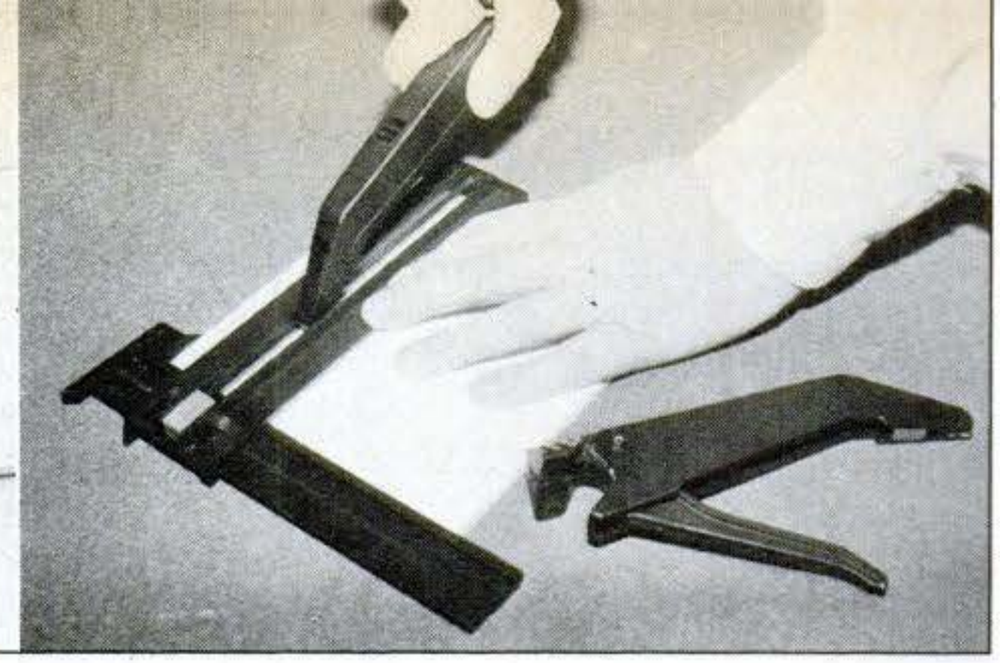
What's New IN TOOLS

BY V. ELAINE SMAY





Tough cutters

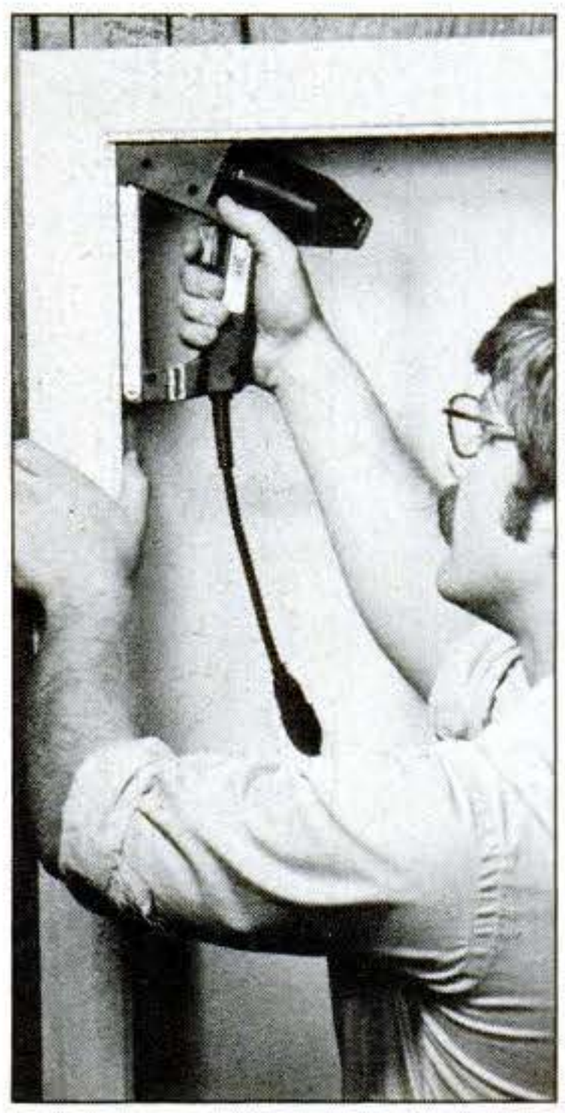
You can shape even abrasive materials, such as hardwood and particleboard, with these new carbide-tip cutters (left) for your shaper, says Rockwell Intl. The company has introduced 30 new cutters, including straight, bead, flute, and ogee profiles, and three cabinet-molding sets.

Two-tool tiling set

Tool one of Tile Master measures the gap that border tiles must fill (above left), transfers the measurement to the tile, and guides the scoring (above). Tool two (shown in both modes) scores and snaps the tile. Plasplugs Ltd., Sheridan House, 11 Vernon St., Derby DE1 1FR, England.

For the sandman

The new Super Sandcat belt sander from Skil (left, top) is a bigger, more aggressive cousin to the original Sandcat. It takes a three-by-18-in. belt (the original takes the 2½-by-16-in. size). Heavy-duty work is easy due to the effortless handling of the six-lb. tool, claims Skil. Price: $80. For finishing the job, Sears will introduce this spring a new sander that's gentle as a kitten. The in-line Craftsman (left, bottom) uses direct, back-and-forth motion. (Dual-motion sanders actually move in a figure-8 in their "straight-line" mode, according to Sears.) Result: You get a glass-smooth finish in minutes instead of the hours it takes with a wood block.

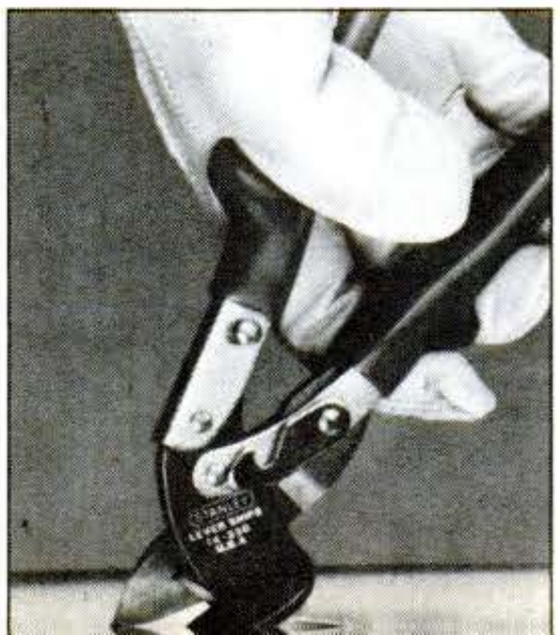


Big band

Here's a band saw that will cut straight lines or curves in stock up to six in. thick and has a frame-to-blade capacity of 9⁷⁄₁₆ in. The Rockwell Model 10 band saw uses a standard 71¾-in. blade. The 10-by-11-in. table tilts 45 deg. for bevel cutting. $353.50 (motor extra).

Hi-tech snips

Compound lever action increases the cutting power of Stanley's nine-in. snips. Result: They can easily cut light-gauge steel, says the maker. They also cut plastic flooring, carpeting, even plastic laminates. And the offset handles save knuckles. Price: $15.



Snub-nosed stapler

You can staple right into a corner with this Craftsman electric stapler ($30 from Sears). Its drive coil is angled back to place the staple within ⅛ in. of a perpendicular surface. The stapler has two power settings: HI for hard materials; LO for soft or thin ones.

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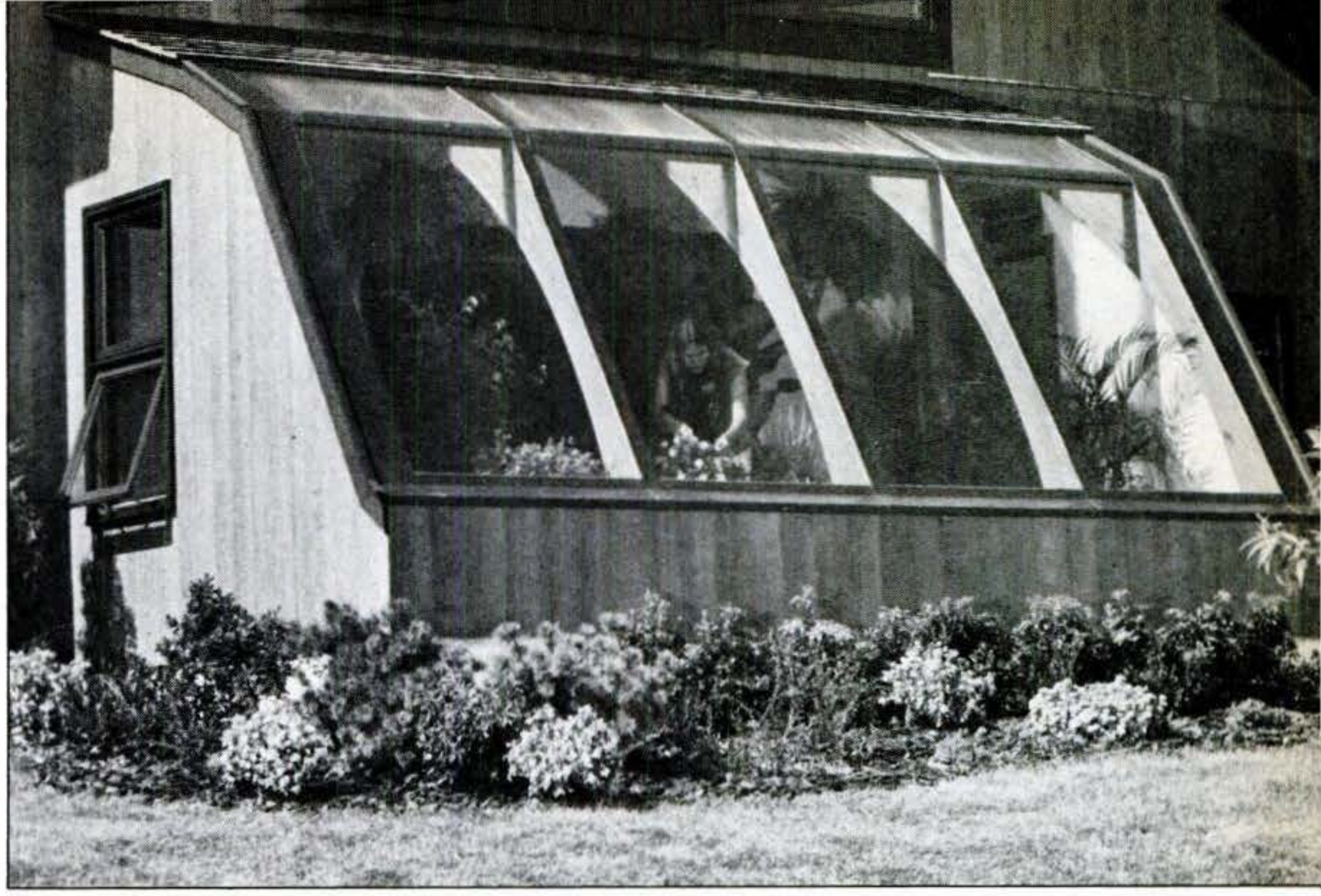
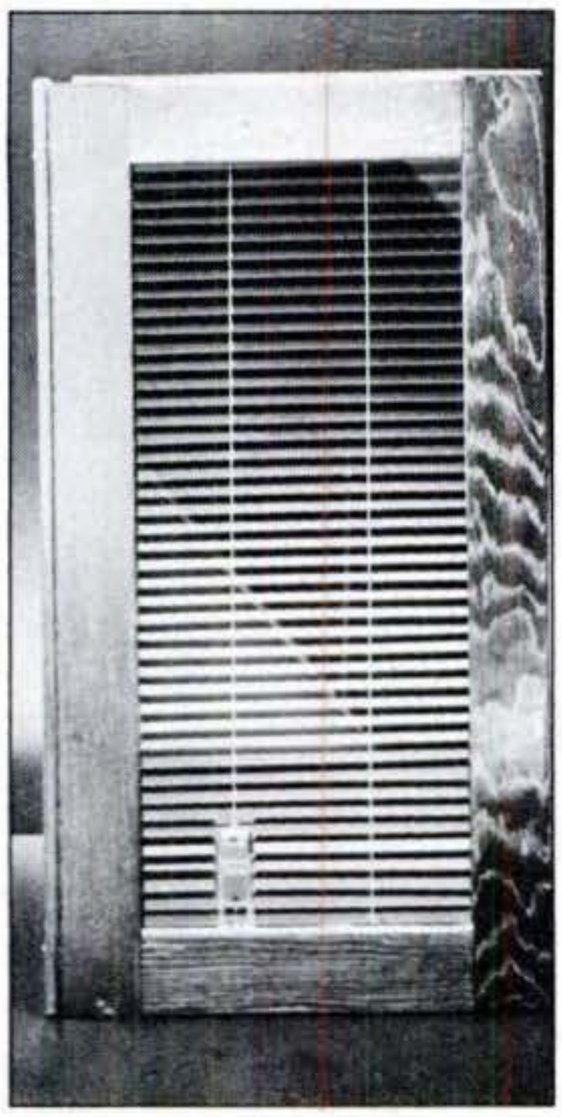
What's New IN HOME IMPROVEMENT

BY SUSAN RENNER-SMITH





Magnetic blind

How do you adjust a Venetian blind that's sealed between two panes of glass? Slide the magnetic outer lever up and down; a magnet inside the space adjusts the aluminum slats. Magna Between-Glass Blind is made by Hunter Douglas, Box 61, Roxboro, N.C. 27573.

Add-on greenhouse

The Sun Room looks like a custom-designed addition, says Garden Way (Box 97, Charlotte, Vt. 05445). The reason? You finish the exterior to match your house. The interior has laminated wood beams, insulated side walls and roof, and double glazing. A data pack is $3.

Wall guard

Children careening around corners can smudge, scratch, and dent your walls. This high-impact plastic protector child-proofs those vulnerable corners. Plaskolite (Box 1497, Columbus, Ohio 43216) makes it. A 48-in. strip costs $1.98; a 96-in. one is $4.19.

Scrubbable matting

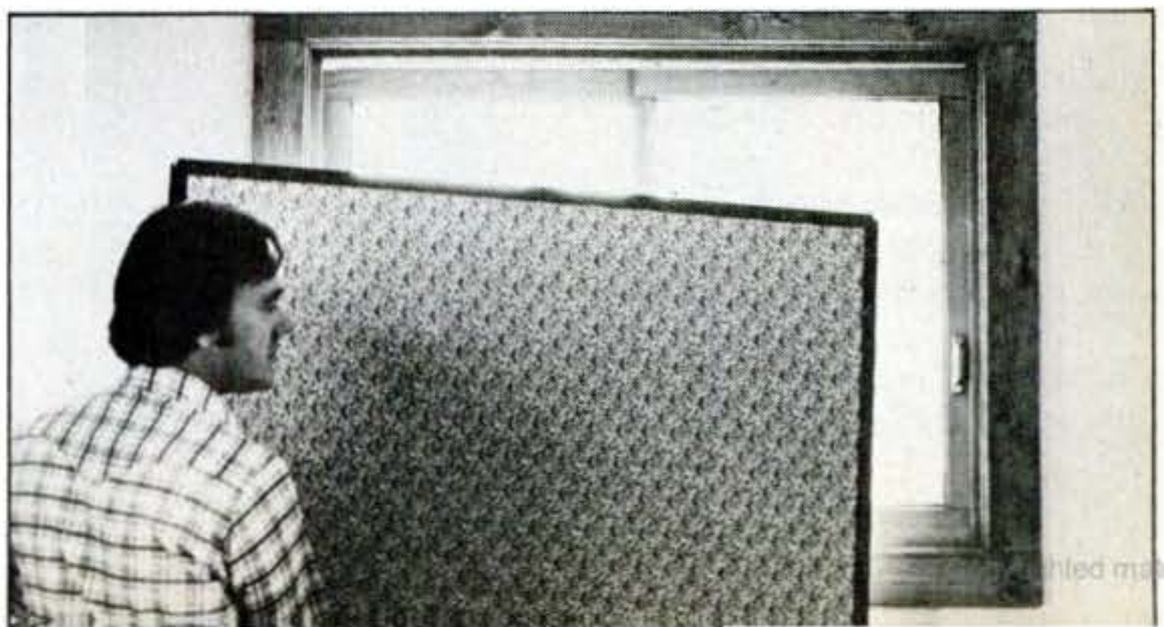
It looks like rush-fiber matting, but it's easier to keep clean. Rustic Weave is Armstrong's newest Sundial Solarian sheet flooring. The wheat-colored pattern has a Mirabond no-wax surface, comes in both six- and 12- ft. widths, costs $11.50 a sq. ft.

Trim wall bed

Designed to fold up flush with standard shelf units, the Sico wall bed is just 18 in. deep. The full-size bed has a slanted, padded headrest that's comfortable for reading in bed. Sico (7525 Cahill Rd., Minneapolis, Minn. 55435) sells it for $2,195 and up.

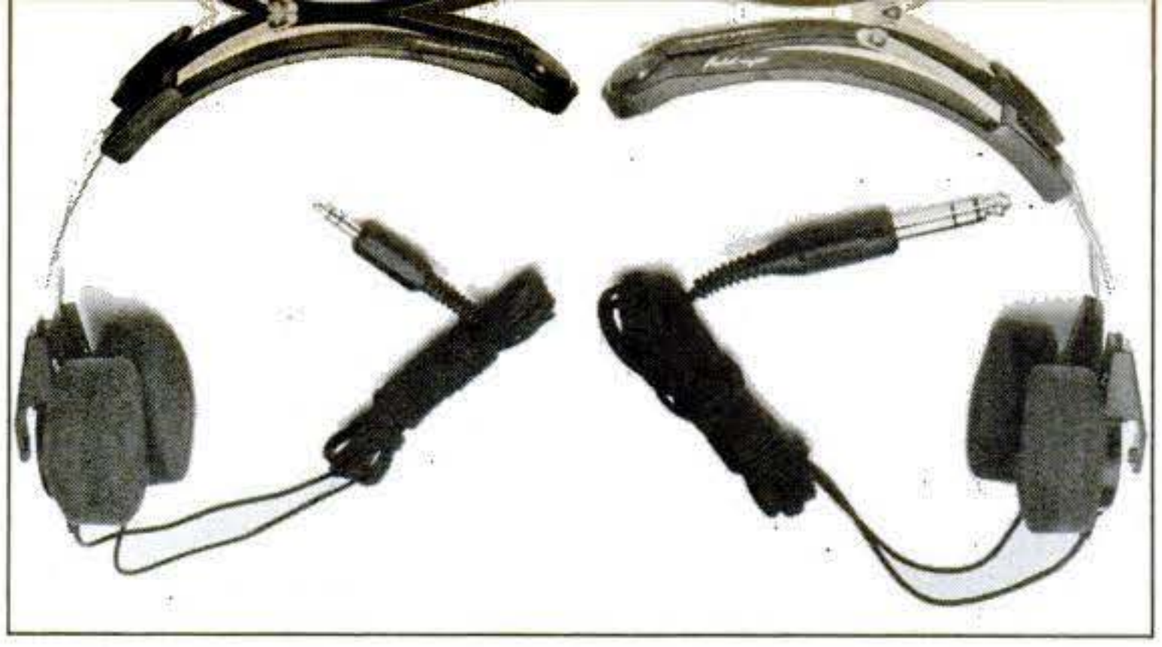
Foam fitter

No fasteners needed—Window Plug lets you press-fit an insulating foam panel into a window frame. The compression edge seal holds the panel in place, prevents air leakage. A six-ft. seal is $5.19 from Star Technology, Box 1187, Carbondale, Colo. 81623.



What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS



Fold-up phones

Portable stereos are convenient to use but awkward to stow away. Unlike unruly earphones that won't fit anywhere but around your neck, Nova earphones from Radio Shack fold up: When you're through, tuck them in a pocket. With either ¼- or ⅛-in. plugs, they're $22.

Fitness computer

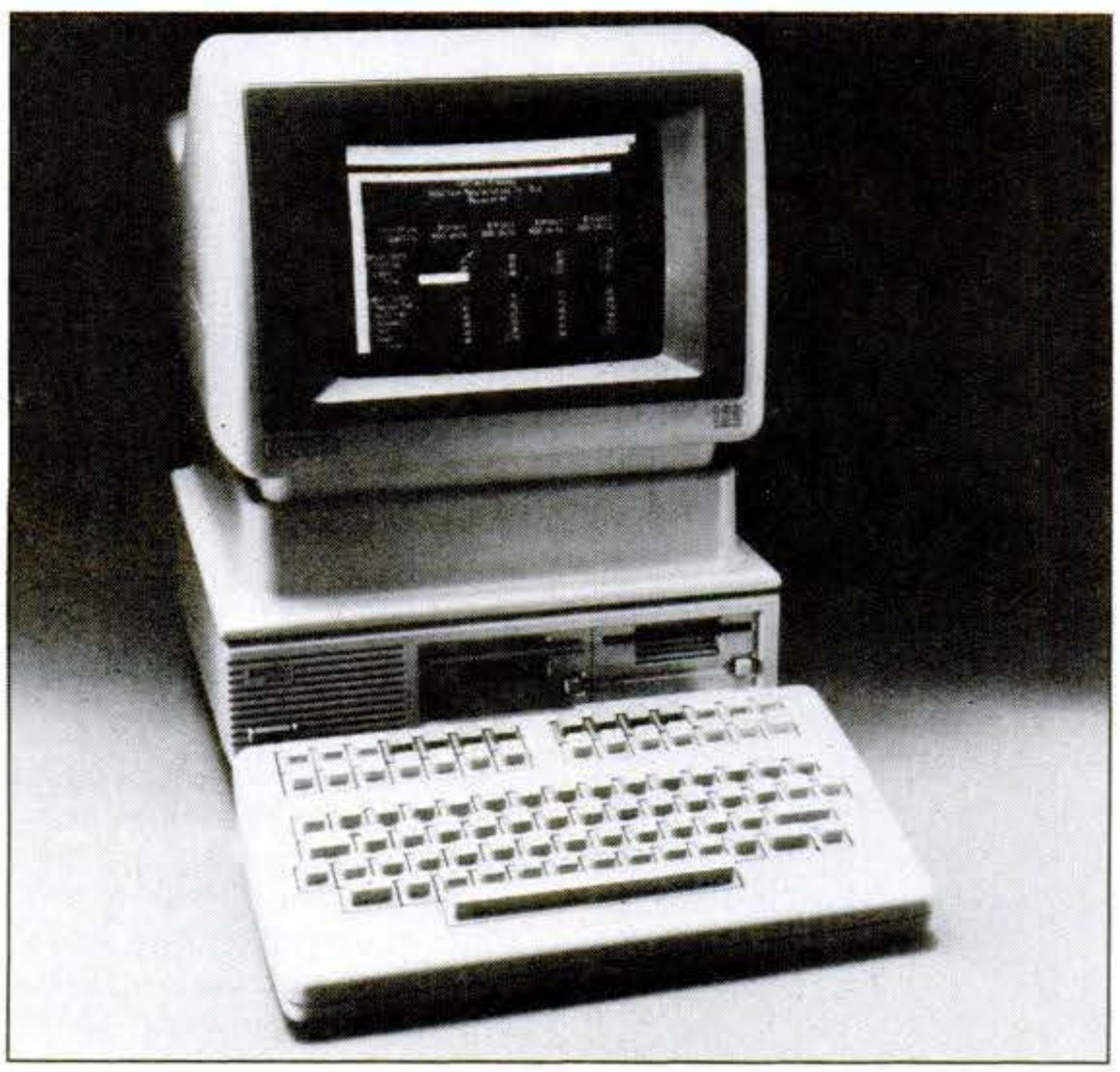
You can't buy a more personal computer—the Coach Aerobic Fitness Monitor clips on your shorts. As you run, it displays heart rate, expended calories, fitness level, speed, distance, strides, and time. Made by Biotechnology (One S.E. 15th Rd., Miami, Fla. 33131), it's $200.

Touch command

Just touch: This Four-Phase Systems (Cupertino, Calif.) intelligent terminal knows what you want. The touch-sensitive screen recognizes up to 32 areas for instant finger-tip control. It won't work by itself, however. It's all part of Four-Phase's model 5000 business-computer system.

Remote alarm

The large box goes in your car; the small one goes in your pocket. Result: You can be up to two miles away, but the pocket beeper sounds off if anyone tries to break in. Model 4000T, made by Page Alert Systems (23842 Hawthorne Blvd., Torrance, Calif. 90505), is about $100.

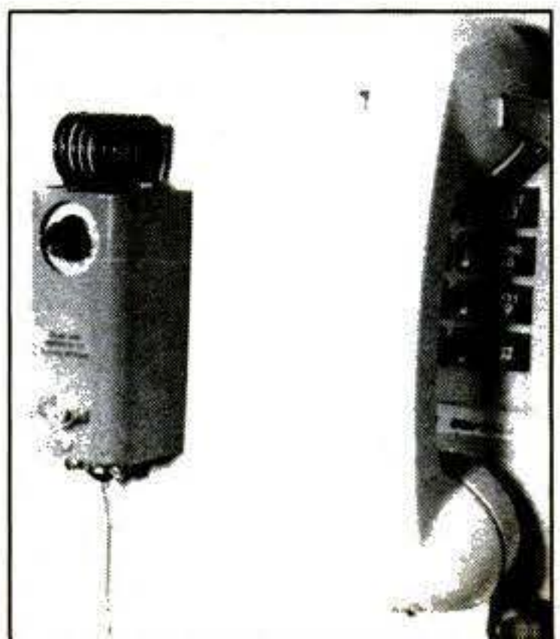


Space saver

It's no bigger than an open loose-leaf book, but don't let its size fool you. The Hewlett-Packard model 120 personal computer uses the CP/M operating system and two eight-bit microprocessors for greater speed, has a dual 3.5-in.-mini-disc drive, 64K of RAM, and full keyboard. Basic price: $2,775.

House checker

To check your summer home in the winter, just call on the phone. If it rings, the temperature within the house is normal. But get a busy signal, and Phone Stat (Box 18035, Lansing, Mich. 48901) is telling you the temperature is dangerously low. Price: $90.



Money memory

Spend your money—the Personal Expense Account Recorder (sold by Hammacher Schlemmer, 39-25 Skillman Ave., Long Island City, N.Y.) will keep track of it all. You can recall any of up to 80 entries by date, type of expense, or name. $150.

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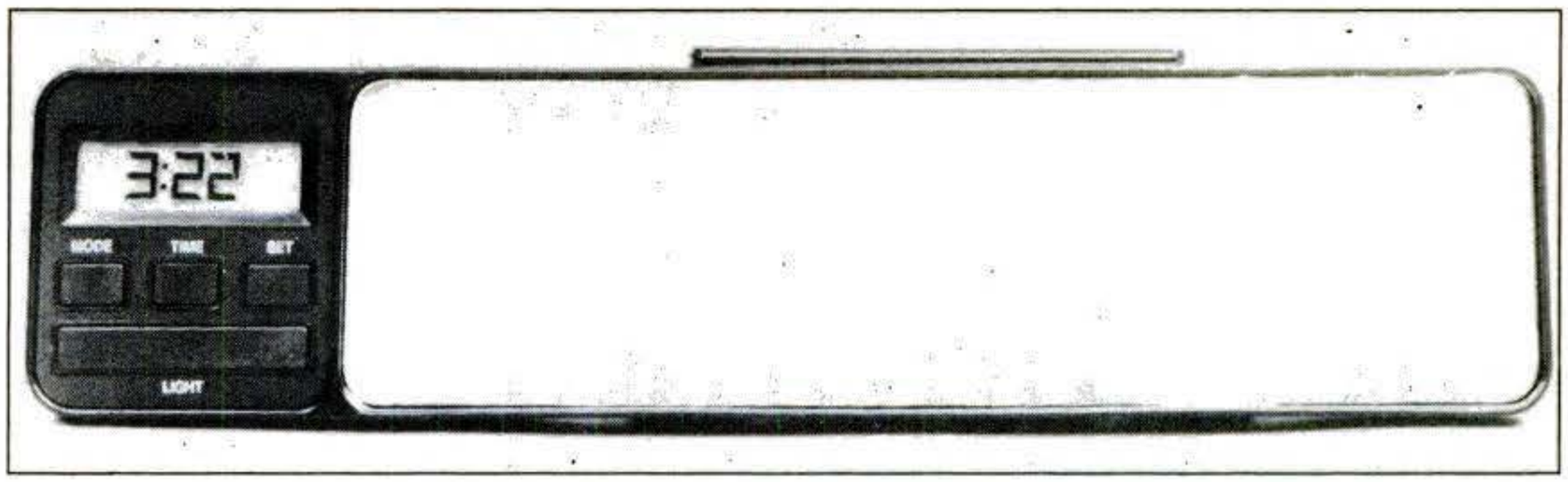
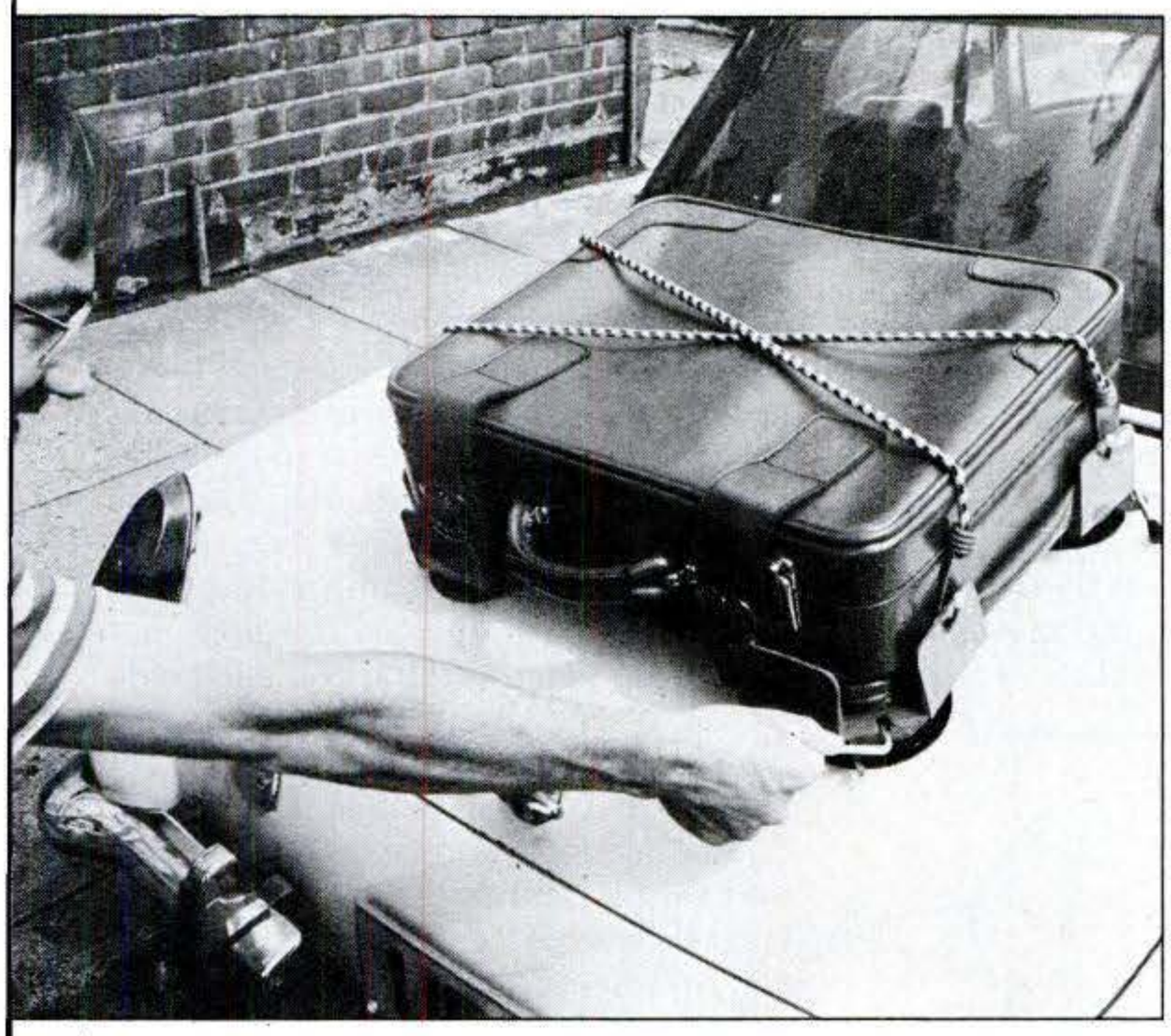
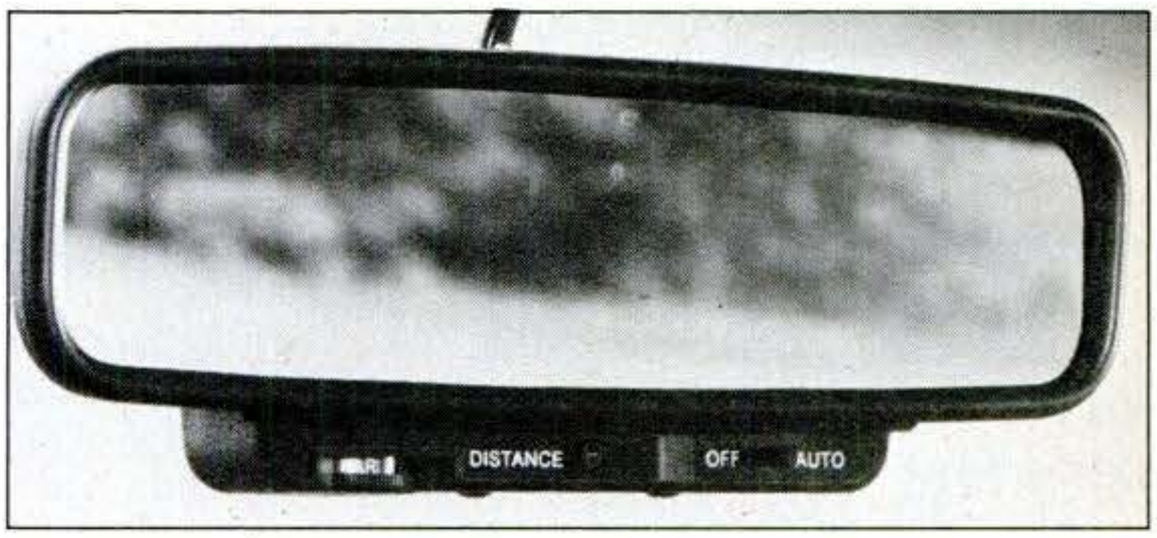
What's New
FOR YOUR CAR

BY JACK KEEBLER





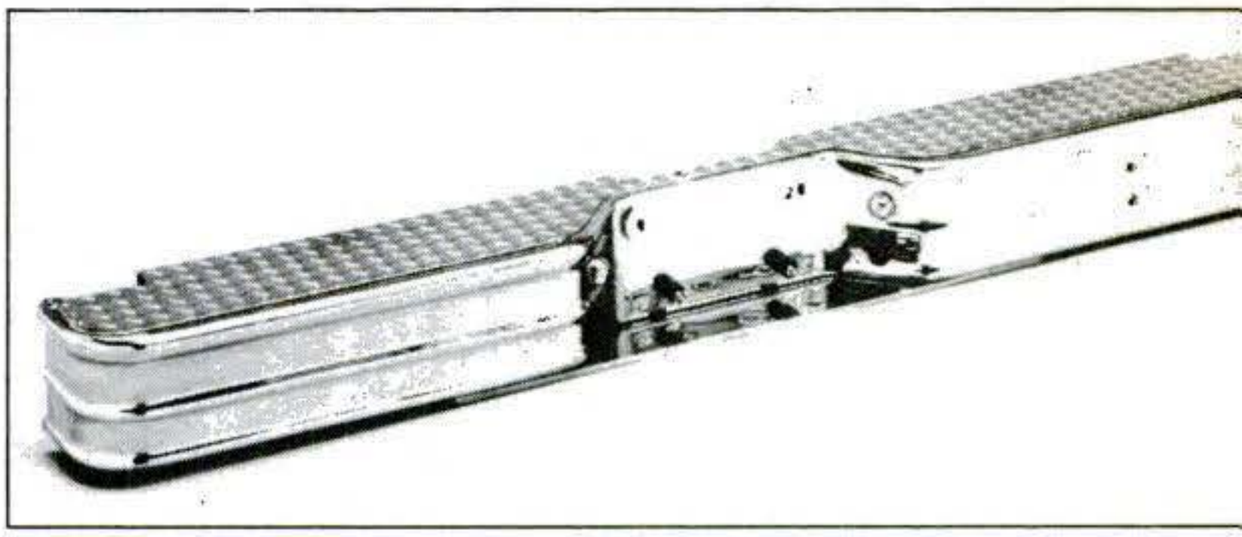


Rear-view review

The two mirrors above reflect the latest in rear-view design. Clip the wide-angle mirror/digital clock (top) to your car's present mirror: You get more viewing area and the time and date at a glance. It's from A.A. Milstan Products Inc. (99 Jericho Tpk., Jericho, N.Y. 11753) and costs $31.45. The Automatic Day/Night mirror above prevents headlamp glare at night. Two photocells detect bright incoming light and tip the mirror to a low-reflectance position. It's made by Donnelly Mirrors, is an $89 option on many '83 Ford models.

Suction-cup rack

These corner supports can go anywhere on your car to provide a snug-fitting rack for awkwardly shaped loads. A single lever installs and releases the vacuum gripper. They stow easily and eliminate wind noise and drag, says A.O.C. Ltd. (Albion Way, Wembley, Middlesex HA9 0TY, England).



Two-way tool

Black & Decker's ¾-hp sander and polisher has two speeds: high speed for autobody repairs; low speed for polishing off those waxing and buffing chores. The seven-in. disc makes big jobs a cinch. Price: $54.77.

Rear-mount winch

A rear-bumper winch-mounting kit can help haul your truck out of sticky situations. With the license-plate bracket in place and remote-control switch removed, you can't tell the vehicle has a winch, says Warn Ind. (19450 68th Ave. S., Kent, Wash. 98031). Mount: $239; winch: $425.

Tiny light

With the Micro-Lite on your key chain, you'll never be without a powerful light. It's four in. long, weighs 1.76 oz., and provides a 1,400 candlepower beam. Tekna (Box 2363, Menlo Park, Calif. 94025) makes it. Price: $5.95.

Rx for taillights

Weather-resistant adhesive vinyl from Trimbrite (Box 67, Holt, Mich. 48842) can provide first aid for your damaged taillight lens. Two kits are available: One has three sheets of amber, red, and clear. Price: $3.11. The second has one red five-by-seven-inch sheet. $1.44.

Traction control

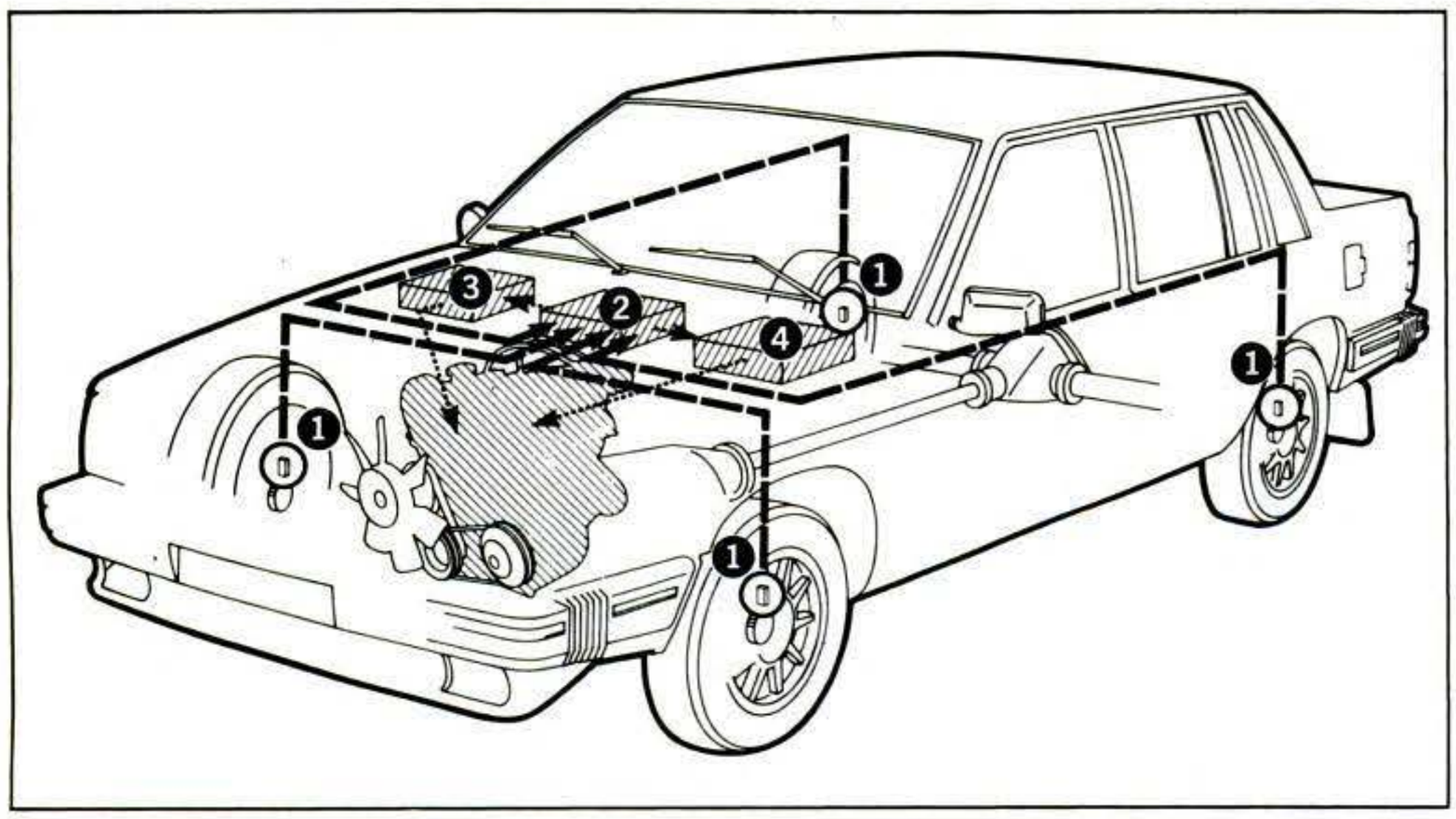
stops wheelspin on jack-rabbit starts

Clever electronic system keeps turbocharged muscle car's feet on the road

By DAVID SCOTT

Burning rubber for slingshot acceleration may nourish a macho ego, but it's a waste of engine power, fuel, and tire tread. And since it means losing traction, such wheelspin is also dangerous. Lateral stability ends when the driven wheels lose their grip.

That was Volvo's motivation for developing Electronic Traction Control to mate with its microprocessor-controlled, 2.1-liter turbocharged engine. This super-performance single-overhead-cam engine can deliver a startling 198 hp and 244 ft.-lbs. of torque in short bursts for swift overtaking. It can also deliver some pretty impressive wheelspin. But the new Electronic Traction Control system allows maximum safe use of this punch by automatically tapering down engine power before wheelspin occurs.



Electronic Traction Control includes rolling-speed sensors (1) on all four wheels feeding pulsed signals to a microprocessor (2). When the difference in wheel-rotation speed (front vs. back on either side) indicates approaching spin, control unit (3) halts turbocharger operation, then unit (4) steps down fuel flow to cylinders.

Traction control is the converse of anti-skid braking, which prevents wheel lockup. The Volvo traction-control system begins with four toothed-wheel magnetic sensors—one fitted to each wheel to register its rotational speed. These generate pulsed signals in individual pickup coils mounted on the front and rear axles, and the rotational speed of each driven wheel is compared with that of the free-rolling front wheel on the same side of the car. Any frequency difference between the paired signals on each side is registered by a microprocessor, which can thus detect the onset of spin by either rear wheel.

When the difference between front- and rear-wheel speed on either side exceeds five percent, the microprocessor directs the trimming of engine output. The reduction is progressive and regulated in two separate ways.

Two-step power trim

The first step is to interrupt the operation of the turbocharger. To do this, the microprocessor trips the turbocharger's waste-gate valve. This diverts some of the exhaust gases that would otherwise go to turn the vanes of the turbo-compressor, and relieves boost pressure in the intake manifold. (The waste-gate valve's normal function is to divert the exhaust gases when the charging pressure approaches a preset maximum.)

If the resultant power drop is not enough to stop wheelspin, the microprocessor then interacts with the electronic fuel injection to the four-cylinder engine. Fuel delivery is regulated in half-cylinder steps by reducing by half the number of fuel-injection pulses to a cylinder. It then fires on alternate power strokes. Initially, only one cylinder is put on a half-time schedule. That cylinder may then be fully deactivated, followed by other cylinders in turn, until wheelspin is arrested and traction restored. The moment this happens, engine power is progressively increased by reversing the cut-down sequence.

The Electronic Traction Control system could make a big contribution to road safety when there is an abundance of turbo power on tap. PS

Test installation on Volvo 760 GLE prevents wheelspin during full-throttle start on loose gravel, when up to 198 hp is on tap from the turbocharged engine. Even on ice, the car can accelerate from rest smoothly and quickly.

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PS car test
& driving report

50+ mpg imports

We test six top fuel savers

By JIM DUNNE and JACK KEEBLER

PHOTOGRAPHS BY GREG SHARKO

Fifty miles per gallon—five years ago that was impressive. But with the trend toward better mpg, continuing fuel-economy improvements will soon become a non-story. The transition has been rapid. Two years ago, when PS began this series on high-mileage imports, the bogy was 40 miles to the gallon. At that time, only a half

Continued

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Dust. Mud. Rocks. Snow. The new 1983 Toyota 4x4 SR5 Long Bed Sport Truck can do it all. Taking you and your gear just about anywhere you want to go. With a sharp sense of style. And a fuel efficient sense of thrift.*

The tough, durable 2.4 liter SOHC engine, working with a 5-speed overdrive transmission, steel radial mud and snow tires, and steel skid plates protecting vital parts, overwhelms the surface you've chosen to challenge.

But as tough as it is on the roads, this 4x4 is easy on you.

Reclining bucket seats. Wall-to-wall cut pile carpeting. Even an AM/FM/MPX stereo. And if you're the kind of guy who reaches for the top, optional power steering and air conditioning will help make it easier.

The 1983 Toyota four-wheel drive SR5 Long Bed Sport. It takes the ruts without if's and's or but's. Because somebody did it right. Built a truck with a sophisticated sense of design. The kind of quality and durability that's made

OH WHAT A FEELING!

TOYOTA

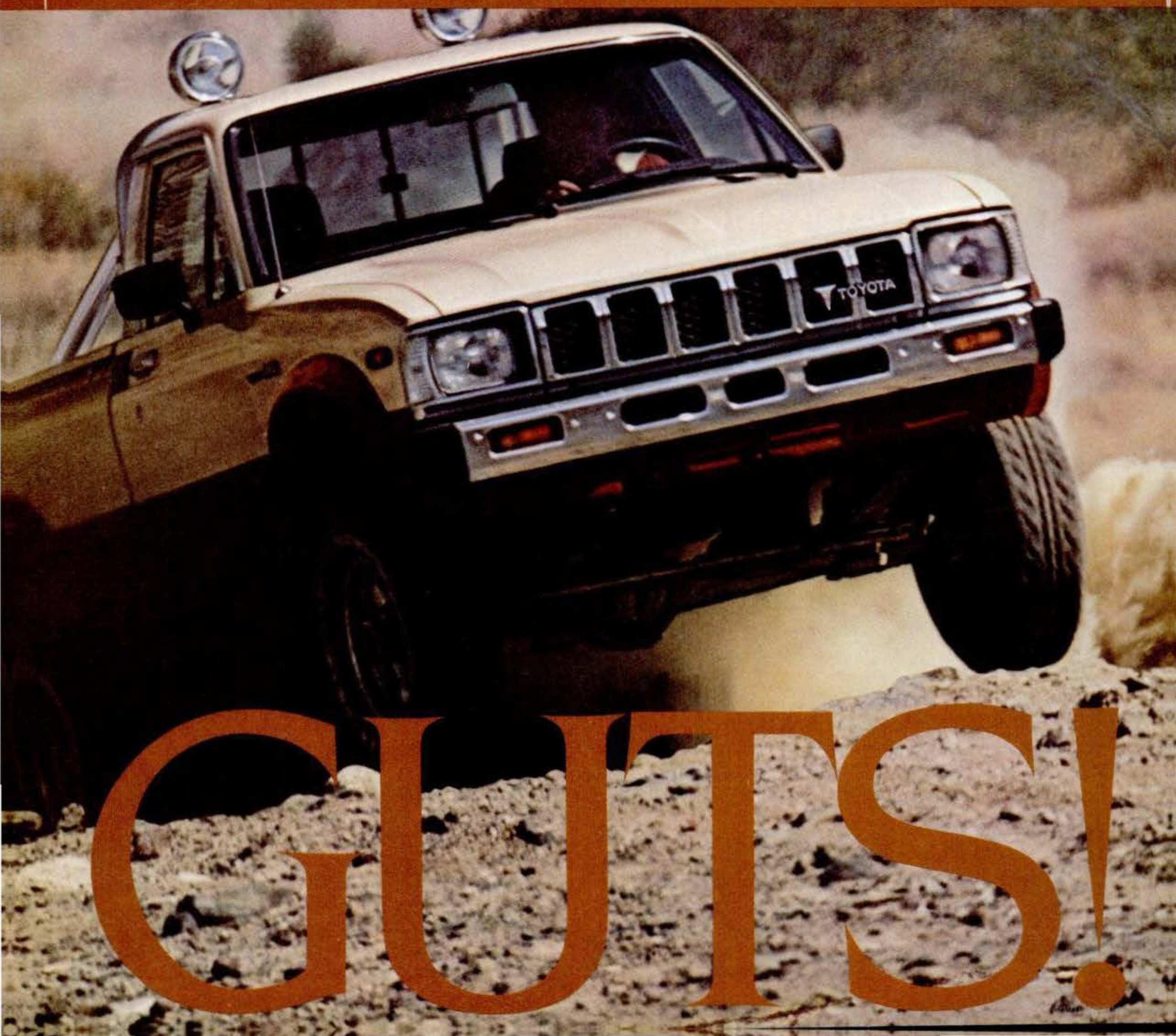
Toyota the world's best selling line of trucks. And one more thing that often goes with guts.

Heart.

*28 Estimated Highway MPG, (21) EPA Estimated MPG. Remember: Compare this estimate to the EPA "Estimated MPG" of other gasoline-powered trucks with manual transmission. You may get different mileage depending on how fast you drive, weather conditions and trip length. Actual highway mileage will probably be less than the "Highway Estimate."

BUCKLE UP—IT'S A GOOD FEELING!

A NO COMPROMISE, 4-WHEEL DRIVE DUST-BUSTER.



dozen qualified. Today, you can choose from more than twice that number of 50+ mpg models. And some of these fuel misers boast 55 to 60 mpg in the EPA highway test.

We chose six of the most economical imports for a comparison test, not only taking them through our exclusive steady-speed economy runs but examining them for performance, handling, noise levels, and general comfort, as well. They are: Nissan (Datsun) Sentra, Plymouth (Mitsubishi-built) Colt, Audi 4000 diesel, Toyota Starlet, Honda Civic FE, and Volkswagen Jetta turbo diesel. Not all of the economy-champion engine-transmission combinations were available at the time of this test (see fuel-mileage box at end of article). Substitutes we examined were close to the most fuel efficient built by each manufacturer.

Nissan Sentra

The newest in the economy lineup is Nissan's replacement for the 210. It gets mid-30s mpg in everyday driving and approaches 50 mpg on the highway. Sentra is bigger inside than the 210: That's obvious from interior dimensions (compare with the 210 we tested in February 1981), and it's something you can see and feel.

Front buckets are comfortably large, although their mostly flat surfaces offer little lateral support during turns. Sentra gets good marks for rear-seat room. It carries two adults easily, and there's plenty of knee room and head room, a real bonus in a car of this size.

The 1.5-liter (90.8 cu. in.) four we tested zips the four-door Sentra from zero to 60 mph in just over 15 seconds. The five-speed overdrive transmission is not set up for fast shifting, though, as we discovered during acceleration runs. Shifting from second to third is difficult if you shift fast. The transmission wants to get back into first or all the way up to fifth.

Plymouth Colt

It says "imported for Plymouth" on the trunk: That means the Colt name is no longer exclusive with the Dodge brand at Chrysler Corp. Our test car was equipped with the intriguing twin-stick transmission, which combines a four-speed manual transmission with a two-ratio input shaft. Interestingly, the setup is not Colt's fuel stingiest. That honor goes to the basic four-speed transmission.

An extra shelf below the Colt's instrument panel triples the glovebox capacity for storage. The LS model we tested had plush velour upholstery and even twin electric side-view mirrors.

Colt's rear seat converts easily from passenger accommodation to cargo platform. Pull one lever on the rear seat back, and the seat folds forward. The floor is uneven and does not reach all the way to the back of the front seats, but it does offer a spacious load surface.

Audi 4000 diesel

True to Audi's modern heritage, the interior is crisply designed and functional. The seats are firm and highly contoured to hold passengers tightly.

Some—but not all—of the diesel problems have been solved by Audi engineers. You can still feel engine shake at idle, but things smooth out when the car reaches 10 mph or more. Start-up on a cold morning means a delay of about 10 seconds while the glow plugs heat up the diesel combustion chambers. And once started, the noise is enough to wake up the neighbors two doors away. After a few minutes of driving, though, the clatter subsides. Still, in our sound-measurement tests the Audi did poorer than gasoline-powered cars that cost thousands of dollars less.

Note, too, that in acceleration the diesel can't compete with gasoline-engine cars. The Audi's 26.7-second time for zero-to-60-mph acceleration is well below just about any gasoline-engine car now on the market.

The diesel engine does not detract one bit from the precision and sureness of Audi's handling. Even with the low-powered engine, the car easily passed our high-speed and maneuverability tests with top marks.

Toyota Starlet

What's a rear-drive car doing among all these front-drives? Only Toyota knows for certain, but the low-priced, two-door Starlet holds its own in our dynamic tests. It got top grades for handling and low-speed maneuverability and easily outdid the front-drive Colt and Sentra in the high-speed test. One weak point: Its puny 79.3-cu.-in. engine makes Starlet the slowest of the gasoline-powered cars. It's significantly quicker than Audi's diesel, though. This year, an expensive-looking fuel-injection system boosts power to cut the zero-to-60-mph time from 22 seconds in the 1982 model to just over 19 seconds. At the same time, Toyota claims an improvement of 10 percent in fuel economy.

Starlet isn't meant to give comfort to rear-seat passengers, who will look in vain for armrests or padding.

Honda Civic FE

While Honda does not claim to have invented good fuel economy, the reputation of its Civic line is built primarily on that feature. In the PS steady-speed economy test the FE lived up to its reputation, posting the best economy of the six models examined.

But the secret to Honda's success goes further than simple fuel economy. Add good performance, a stable chassis at speed, and the appearance

Continued

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Sentra	Colt	4000	Starlet	Civic FE	Jetta
Acceleration	4	4	0	2	5	4
Braking	2	2	3	2	2	1
Handling	2	3	5	5	5	3
Maneuverability	5	5	5	5	5	5
Quietness	1	1	0	1	1	0
Roominess	3	3	3	2	2	3
Vision	5	5	5	5	5	4
Entry/exit ease	3	2	3	2	3	3
EPA economy	5	5	5	5	5	5
Ride comfort*	2	2	3	2	2	3

*Authors' opinion

Performance comparison with selected models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1982 Dodge Colt 4	39	18.9	165	59.8	27.6+	75
1982 Toyota Starlet 4	38	22	196	58.8	27.6+	74
1983 AMC Alliance 4	34	18.9	176	63.7	29.9	68
1983 Ford Escort 4	33	15.6	173	61.2	30.1	66
1983 VW Rabbit diesel 4	43	23.8	157	62.8	29.5	73

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Nissan Sentra (opening page) scored the best 60-mph sound-level rating (72 dBA) of the six cars tested. Its rack-and-pinion steering and small size made it highly maneuverable. Audi 4000 (clockwise, starting at left) exhibited good brake performance. It stopped shorter than some models weighing several hundred pounds less. Plymouth Colt is well equipped. In fact, it offers a strong emphasis on luxury. Early economy-car rubber mats and high sound levels have given way to plush carpeting, rich velour fabrics, and better sound reduction. Honda Civic FE is the EPA's gas-engine economy champ (46-59 city-highway). We were impressed with its smooth-revving engine and well-finished interior and exterior. VW Jetta turbo diesel doesn't perform like a diesel. Maximum torque comes in at a low 2,800 rpm, ensuring sprightly performance. Toyota Starlet is bare-bones simple, except for one item. Under the hood lurks a potent-looking electronic multi-point fuel-injection system (inset). The system's microcomputer precisely adjusts fuel flow for improved performance, mileage, and overall drivability.

of high-quality workmanship inside and out. You see no skimping in the instruments, which include a tach and trip odometer. There's even a lever at the driver's left to unlock the hatch.

Up front, the space is fine; in the back seat, space is barely adequate for two adults. Knee room is tight—so much so that passengers' knees push up against the front seat backs.

Fortunately, the hatchback design turns this small car into a big load carrier. A release button swings the rear seat back forward; you reach it from inside the car or from the hatch.

VW Jetta turbo diesel

Nothing much has changed on the outside. The interesting things have happened in the engine bay. Jetta's 68-hp turbocharged diesel offers most undiesel-like performance, delivering 98 ft.-lbs. of torque at a low 2,800 rpm. Off the line, Jetta spins its wheels for about 12 feet. Even grabbing second gear produces a loud chirp. In fact, the 15.3-second zero-to-60 time beats the naturally aspirated Jetta diesel in our March 1982 test by 13.2 seconds.

Jetta's handling is neutral, with understeer at the car's limit. Only abrupt changes in direction at high speed provoked breakaway or oversteer.

Jetta's seats, firm and sharply contoured for good support, are covered with a handsome, grippy maroon-and-white tweed. This same fabric was stretched over the door-trim panels, giving the interior a rich, integrated appearance. The wheel is the same padded four-spoke unit used in the sporty GTI Rabbit. Jetta's tall greenhouse admits plenty of light, provides excellent vision, and reduces the feeling of claustrophobia common in most small sedans.

Our picks

I'm prejudiced against diesels because of their noise, smell, and low power, but if I were forced to choose one, the Jetta turbo diesel would be it. Among the others, Civic and Colt are my favorites, with Civic getting my nod as best of all. Somehow Honda makes this subcompact ride and drive like a 4,000-pound heavyweight.—J. D.

The Jetta turbo diesel is a whole new way to get there quickly and cheaply. Its ample power and fuel efficiency make it my favorite.—J. K.

For specs and test results, turn page

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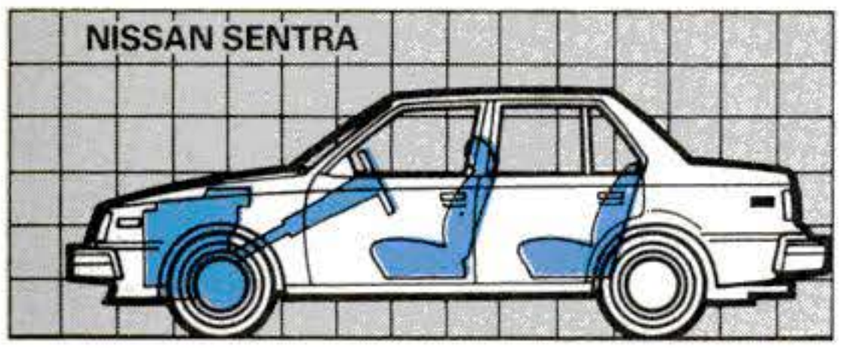

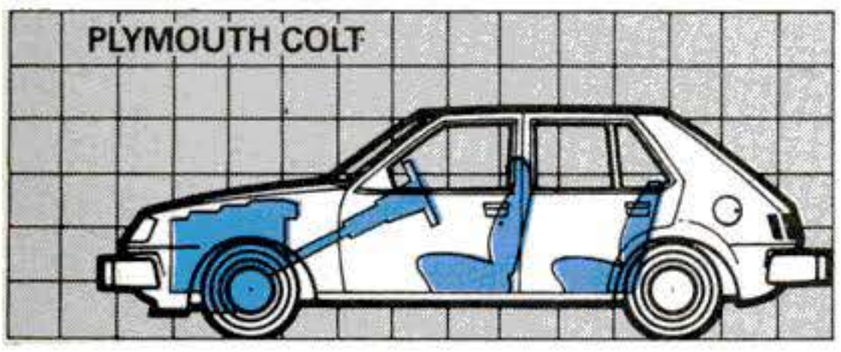

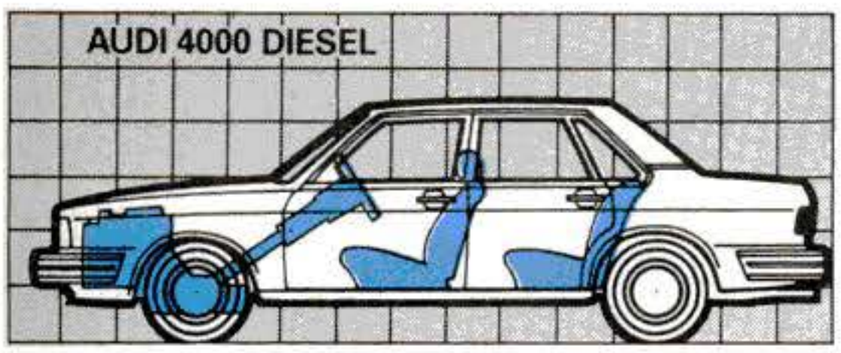

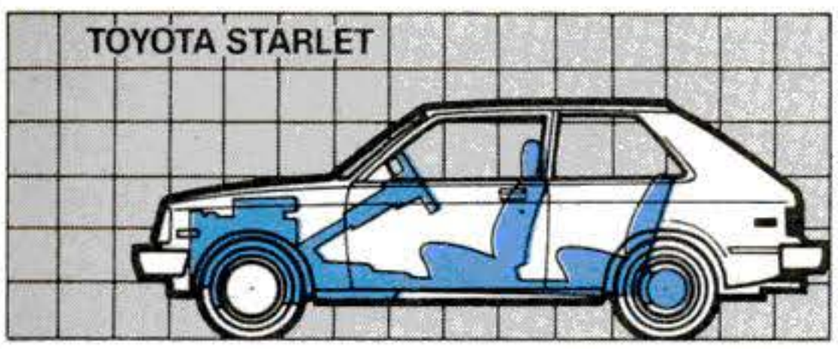

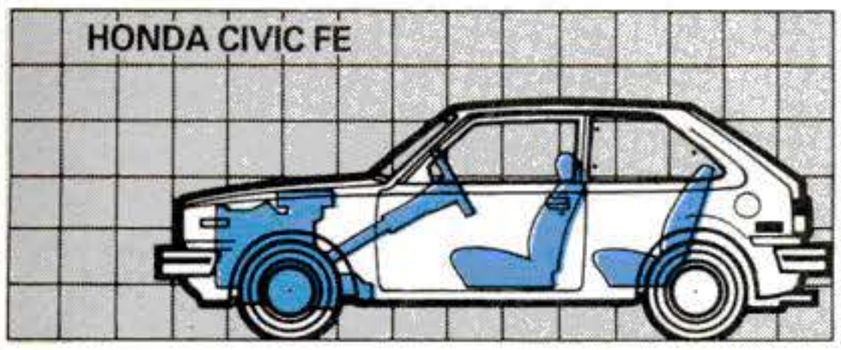

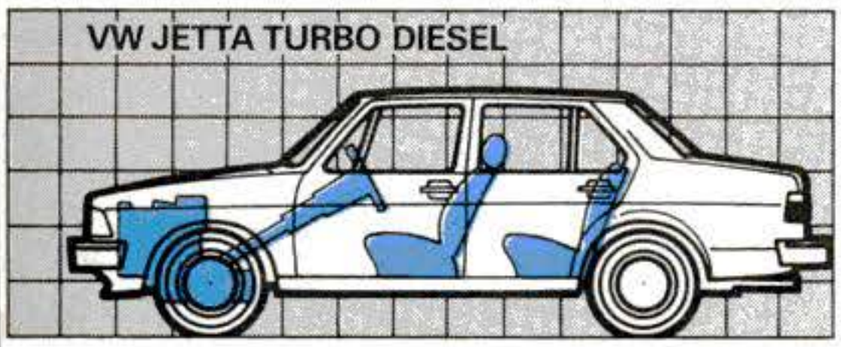

Toyota Starlet is the only rear-drive here. Getting good mileage starts with weight reduction; auto designers agree that the most space-efficient and lightweight power trains are front-drive.

EPA fuel mileage (mpg)

	Sentra*	Colt*	4000	Starlet	Civic FE	Jetta
Highway	50	43	52	54	59	56
City	35	32	39	42	46	43
Calif. city	33	31	39	42	43	43

*Top engine-transmission not available for test (Colt 4-speed rates 53 hwy., 39 city; Sentra diesel 4-speed rates 62 hwy., 48 city)

PS fuel-mileage tests
(steady-state mpg)

35 mph	50	39	57	49	57	56.5
55 mph	38	34	41	37	43	38.4

Nissan Sentra, Plymouth Colt, Audi 4000 diesel, Toyota Starlet, Honda Civic FE, and VW Jetta turbo diesel—dimensions, specs, and test results

DIMENSIONS (inches)	Nissan Sentra	Plymouth Colt	Audi 4000 diesel	Toyota Starlet	Honda Civic FE	VW Jetta turbo diesel
Wheelbase	94.5	93.7	99.5	90.6	88.6	94.5
Overall length	167.3	161.1	176.7	152.2	148.4	167.8
Overall height	54.5	50	53.7	53	52.2	55.5
Overall width	63.7	62.6	66.2	60	62.2	63.4
Track, F/R	54.9/54.1	53.8/52.8	55.1/55.9	50.7/50.2	53.5/54.3	54.7/53.1
Ground clearance	6.5	7	4.6	7	6	4.9
Front head room	37	36	37	37.3	36	36
Front hip room	44	42	48	42	40	42
Front leg room	44	41.5	45	40.9	42	40
Rear head room	35	35	33	36	33	34
Rear hip room	51	48	48	45	52	50
Rear leg room (min.)	36.5	35	36	29.1	25	36
Rear knee room (min.)	2	2	3	−0.5	−1	−1
Couple distance	33	30	33	28	26	30
SPECIFICATIONS						
Engine type	In-line 4	In-line 4	In-line 4	In-line 4	In-line 4	In-line 4
Displacement (cu. in./L)	90.8/1.5	98/1.6	97/1.6	79.3/1.3	79.3/1.3	97/1.6
Compression ratio	9.0:1	8.5:1	23:1	9.5:1	9.3:1	23:1
Carburetion	2 bbl.	2 bbl.	F.I.	F.I.	3 bbl.	F.I.
Net hp @ rpm	67 @ 5,600	72 @ 5,000 •	52 @ 4,800	58 @ 4,200	60 @ 5,500	68 @ 4,500
Net torque (ft.-lbs.) @ rpm	85 @ 3,200	85 @ 3,000	71.5 @ 2,000	74 @ 3,400	68.2 @ 4,000	98 @ 3,000
Transmission	5-speed manual	4-speed manual (×2)	5-speed manual	4-speed manual	5-speed manual	5-speed manual
Axle ratio	3.364:1	3.47:1	4.11:1	2.929:1	3.722:1	3.89:1
Tire make	Dunlop	B.F. Goodrich	Goodyear	Dunlop	Dunlop	Continental
Tire type	SP 4n steel radial	Steel-belted radial	Grand Prix 570	SP 4n steel radial	SP 4n steel radial	TS 771 steel radial
Tire size	155SR13	175/70R13	175/70SR13	145/SR13	165/70R13	175/70R13
Steering	Power, rack and pinion	Rack and pinion	Power, rack and pinion	Rack and pinion	Rack and pinion	Rack and pinion
Overall steering ratio	18.45:1	22:1	22.4:1	15.7:1	17.9:1	20.8:1
Turns, lock to lock	3.1	3.2	4.25	3.1	3.6	3.9
Turn diameter (ft.)	29.5	30.3	38.5	30.2	35.5	31.2
Front suspension	Independent struts, coil springs	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs	Independent MacPherson struts, coil springs
Rear suspension	Independent trailing arms, coil springs	Independent trailing arms, coil springs	Independent torsion crank axle, coil springs	Solid axle, four control limbs, coil springs	Independent MacPherson struts, coil springs	Independent torsion beam axle, coil springs
Front stabilizer-bar diameter (in.)	None	0.55	0.82	0.86	None	None
Rear stabilizer-bar diameter (in.)	None	None	0.71	None	None	None
Trailer towing (max. lbs.)	1,000	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended
Trailer tongue weight (max. lbs.)	100	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended
Brakes	Disc/drum	Disc/drum	Disc/drum	Disc/drum	Disc/drum, power	Disc/drum, power
Brake swept area (sq. in.)	141.17	216.8	n.a.	197.9	206.8	n.a.
Fuel tank (gal.)	13.2	10.6	15.8	10.6	10.8	10.6
Trunk space (cu. ft.)	11.3	11	12	10	10	13
Liftover height (in.)	33	30	29	23	23	30
Curb weight (lbs.)	1,855	1,982	2,260	1,755	1,795	2,026
F/R weight distribution (%)	55/45	63/37	63/37	54/46	61/39	60/40
Basic price	$6,199*	$6,169	$12,425	$5,798	$5,999	$9,760
Price as tested	$6,974*	$7,354	$13,800	$6,768	$6,368	$11,395
Major options (over $100) on test car	A/C $610*	L.S. package $617, AM-FM stereo $212	Metallic paint $285, AM-FM stereo $690	AM-FM $250, A/C $580	AM-FM $200	AM-FM-cassette stereo $565, alloy wheels $380, A/C $690
TEST RESULTS						
Acceleration (sec.) 0–60 mph	15.1	15.2	26.7	19.1	14.4	15.3
Brake test (cool) 60–0 mph						
Stopping distance (ft.)	171	168	161	168	182	155
Pedal pressure (lbs.)	110	100	90	40	80	50
Brake test (hot) 60–0 mph						
Stopping distance (ft.)	181	176	164	178	178	191
Pedal pressure (lbs.)	125	125	55	85	150	78
Interior noise @ 60 mph (dBA)	72	74	76	74	73	76
Handling test (mph)	56.5	59.5	67.5	66	65	60
Maneuverability test (mph)	28.3	29.3	28.6	29	30.3	29.3

TEST CONDITIONS: Ambient temperature, 62°F; relative humidity, 68 percent; barometric pressure, 29.7 inches Hg
*1982 prices

PS serviceability ratings

The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Checking fluid levels					Checking the engine					Replacing hoses			Changing bulbs						Checking fuses	Spare-tire accessibility	Changing belts
	Battery	Master cylinder	Windshield washer	Engine oil	Coolant	Spark plugs	Distributor	Carb adjustment	Oil filter	Oil fill	Upper radiator hose	Lower radiator hose	Heater hoses	Headlights	Taillights	Front running lights	Front parking lights	Front directionals	Rear directionals	Rear running lights			
Nissan Sentra	5	5	5	3	5	5	5	*	2	4	5	4	3	5	5	3	3	3	5	3	5	3	3
Plymouth Colt	5	5	5	5	5	5	5	*	3	5	5	5	2	3	3	3	3	3	3	4	5	4	4
Audi 4000 diesel	5	5	5	5	5	-	-	-	5	5	5	4	2	2	5	3	3	3	5	5	4	5	2
Toyota Starlet	5	5	5	5	5	5	4	F.I.	4	3	5	4	4	3	5	3	3	3	5	5	5	5	4
Honda Civic FE	5	4	5	5	5	5	5	*	5	4	5	4	4	4	5	3	3	3	5	5	5	4	4
VW Jetta turbo diesel	5	5	5	5	5	-	-	-	4	5	5	3	4	3	5	4	4	3	5	5	4	5	2

*Sealed

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Economy imports

What can you buy for less than $7,500?

PS buyer's guide to imports under $7,500

Manufacturer model	Length (in.)	Width (in.)	Height (in.)	Weight (lbs.)	Engine (liters)	Horsepower	Trans-mission	Body type	Base price ($)
Dodge/Plymouth									
Colt	156.9	62.4	50.0	1,951	1.4, OHC 4	64 @ 5,000	4-sp. man., 2×4-sp. man., 3-sp. auto.	2-dr. hatch.	4,995
								4-dr. hatch.	5,547
Honda									
Civic 1300	148.4	62.2	53.1	1,773	1.3, OHC 4	60 @ 5,500	4-sp. man.	2-dr. hatch.	4,899
Civic 1300 FE	148.4	62.2	53.1	1,803	1.3, OHC 4	60 @ 5,500	5-sp. man.	2-dr. hatch.	5,999
Civic 1500 DX	148.4	62.2	53.1	1,867	1.5, OHC 4	67 @ 5,000	5-sp. man., 3-sp. auto.	2-dr. hatch.	5,949
Civic 1500 S	148.4	62.2	53.1	1,898	1.5, OHC 4	67 @ 5,000	5-sp. man.	2-dr. hatch.	6,399
Civic	161.4	62.2	53.1	1,973	1.5, OHC 4	67 @ 5,000	5-sp. man., 3-sp. auto.	4-dr. sedan	6,849
	161.4	62.2	54.1	2,033	1.5, OHC 4	67 @ 5,000		4-dr. wagon	6,349
Isuzu									
I-Mark Deluxe (gas)	170.7	61.8	52.6	2,189	1.8, OHC 4	78 @ 4,800	5-sp. man., 3-sp. auto.	2-dr. coupe	6,436*
	170.7	61.8	53.5	2,231	1.8, OHC 4	78 @ 4,800		4-dr. sedan	6,598*
I-Mark LS (gas)	170.7	61.8	52.6	2,207	1.8, OHC 4	78 @ 4,800		2-dr. coupe	6,957*
	170.7	61.8	53.5	2,260	1.8, OHC 4	78 @ 4,800		4-dr. sedan	7,073*
I-Mark (diesel)	170.7	61.8	52.6	2,233	1.8, OHC 4	51 @ 5,000	4-sp. man.	2-dr. coupe	n.a.
I-Mark Deluxe (diesel)	170.7	61.8	52.6	2,286	1.8, OHC 4	51 @ 5,000	5-sp. man., 3-sp. auto.	2-dr. coupe	6,867*
	170.7	61.8	53.5	2,335	1.8, OHC 4	51 @ 5,000		4-dr. sedan	7,316*
I-Mark LS (diesel)	170.7	61.8	52.6	2,297	1.8, OHC 4	51 @ 5,000		2-dr. coupe	7,479*
	170.7	61.8	53.5	2,346	1.8, OHC 4	51 @ 5,000		4-dr. sedan	n.a.
Mazda									
GLC	159.1	64.2	54.1	1,890	1.5, OHC 4	68 @ 5,000	4-sp. man., 5-sp. man., 3-sp. auto.	2-dr. hatch.	5,295
	165.4	62.8	56.3	2,130	1.5, OHC 4	63 @ 5,000		4-dr. hatch.	6,345
GLC Sport	166.8	64.2	54.1	1,935	1.5, OHC 4	68 @ 5,000		4-dr. sedan	6,245
Mitsubishi									
Tredia	172.4	65.0	53.7	2,205	1.8, OHC 4	82 @ 5,000	5-sp. man.	4-dr. sedan	6,539
Nissan (Datsun)									
Sentra	167.3	63.7	54.5	1,850	1.6, OHC 4	69 @ 5,200	5-sp. man.	2-dr. sedan	4,949
Sentra MPG	167.3	63.7	54.5	1,840	1.5, OHC 4	69 @ 5,200	5-sp. man.	2-dr. sedan	5,699
Sentra Deluxe	167.3	63.7	54.5	1,850	1.6, OHC 4	69 @ 5,200	5-sp. man., 3-sp. auto.	2-dr. sedan	5,999
	167.3	63.7	54.5	1,855	1.6, OHC 4	69 @ 5,200		4-dr. sedan	6,199
	172.2	63.7	53.5	1,960	1.6, OHC 4	69 @ 5,200		4-dr. wagon	6,649
Sentra Coupe	167.3	63.7	53.5	1,915	1.6, OHC 4	69 @ 5,200		2-dr. hatch.	6,599
Stanza	170.9	65.2	53.9	2,190	2.0, OHC 4	88 @ 5,200		2-dr. hatch.	6,999
	173.4	65.6	54.7	2,215	2.0, OHC 4	88 @ 5,200		4-dr. hatch.	7,199
Pulsar NX	162.4	63.7	53.3	1,907	1.6, OHC 4	69 @ 5,200		2-dr. coupe	7,399
Renault									
Le Car	142.5	60.0	55.0	1,820	1.4, OHV 4	n.a.	4-sp. man.	2-dr. hatch.	4,795
Le Car Deluxe	142.5	60.0	55.0	1,820	1.4, OHV 4	n.a.	4-sp. man.	2-dr. hatch.	4,995
	142.5	60.0	55.0	1,820	1.4, OHV 4	n.a.	4-sp. man.	4-dr. hatch.	5,295
Subaru									
STD	156.9	63.4	53.7	2,050	1.6, OHV 4	69 @ 4,800	4-sp. man.	2-dr. hatch.	4,887*
DL	156.9	62.4	53.7	2,060	1.6, OHV 4	69 @ 4,800	5-sp. man.	2-dr. hatch.	5,852*
	167.3	63.4	53.7	2,130	1.6, OHV 4	69 @ 4,800	5-sp. man.	4-dr. sedan	6,205*
	168.5	63.4	54.7	2,250	1.8, OHV 4	73 @ 4,400	5-sp. man.	4-dr. wagon	6,458*
DL Hardtop	167.3	62.4	53.7	2,110	1.6, OHV 4	69 @ 4,800	5-sp. man.	2-dr. sedan	6,357*
GL	156.7	63.8	55.7	2,235	1.8, OHV 4	73 @ 4,400	4-sp. dual-range	2-dr. hatch.	6,958*
	157.9	63.6	53.7	2,120	1.8, OHV 4	73 @ 4,400	5-sp. man., 3-sp. auto.	2-dr. hatch.	6,352*
	168.1	63.6	53.7	2,190	1.8, OHV 4	73 @ 4,400	5-sp. man.	4-dr. sedan	6,705*
	169.3	63.6	54.7	2,310	1.8, OHV 4	73 @ 4,400	5-sp. man.	4-dr. wagon	6,958*
GL 4WD	156.7	63.8	55.7	2,235	1.8, OHV 4	73 @ 4,400	4-sp. man.	2-dr. hatch.	6,958*
	168.3	63.8	56.9	2,365	1.8, OHV 4	73 @ 4,400	4-sp. man.	4-dr. wagon	7,564*
GLF Hardtop	168.1	63.6	53.7	2,180	1.8, OHV 4	73 @ 4,400	5-sp. man.	2-dr. sedan	6,958*
Toyota									
Tercel Liftback	158.7	63.6	54.5	1,985	1.5, OHC 4	60 @ 4,500	4-sp. man.	2-dr. hatch.	4,998
SR5 4WD Deluxe	169.7	63.6	59.0	n.a.	1.5, OHC 4	62 @ 4,800	6-sp. man. (overdrive)	4-dr. wagon	7,398
Starlet	153.5	60.0	54.3	1,755	1.3, OHC 4	58 @ 4,200	4-sp. man.	2-dr. hatch.	5,798
	153.5	60.0	54.3	1,755	1.3, OHC 4	58 @ 4,200	5-sp. man.	2-dr. hatch.	5,838
Corolla	166.3	63.4	53.0	2,066	1.6, OHC 4	70 @ 4,800	4-sp. man.	2-dr. sedan	5,448
	168.9	63.4	53.0	n.a.	1.6, OHC 4	70 @ 4,800	5-sp. man.	4-dr. wagon	6,508
Corolla Deluxe	166.3	63.4	53.0	n.a.	1.6, OHC 4	70 @ 4,800	5-sp. man.	2-dr. sedan	6,018
	166.3	63.4	53.0	n.a.	1.6, OHC 4	70 @ 4,800	5-sp. man.	4-dr. sedan	6,138
	168.3	64.0	50.8	n.a.	1.6, OHC 4	70 @ 4,800	5-sp. man.	2-dr. hatch.	7,208
SR5 Sport Coupe	168.3	64.0	50.8	n.a.	1.6, OHC 4	70 @ 4,800	5-sp. man.	2-dr. hatch.	7,308
SR5 Hardtop	168.3	64.0	50.8	n.a.	1.6, OHC 4	70 @ 4,000	5-sp. man.	2-dr. sedan	7,248

*Estimated

The race is on as foreign makers pump excitement into the economy package

By JACK KEEBLER

Buying a small car used to mean you wanted cheap, high-mile-per-gallon transportation. In fact, good mileage took precedence over such normal buyer considerations as comfort, quietness, styling, and certainly performance.

Then fuel prices leveled off.

Suddenly, car buyers were asking not only about EPA numbers but also about handling packages, high-performance wheel and tire options, and sports instrumentation and interiors. Cars such as the muscular Toyota Supra and Datsun ZX were selling out. Practical, three-box types sat on the lots unnoticed. It was obvious that buyer excitement was back, and it was selling cars. Result: The newest small imports are not only economical to buy and operate, they're fun to drive. Many makers either have added a sport version to existing models or have added completely new, sportier models. Here's a look at some of the more interesting cars importers are offering.

Dodge/Plymouth: The Champ nameplate is dead. Both Chrysler divisions will call their Mitsubishi-built car Colt. The grille has received a more aerodynamic appearance. The instrument panel has been cleaned up and is much easier to read and use. Colts with automatic transmission have a longer final-drive ratio this year, up from 3.17 to 2.8. Shifting Mitsubishi's Twin-Stick manual transmission is fun. The economy range

Continued

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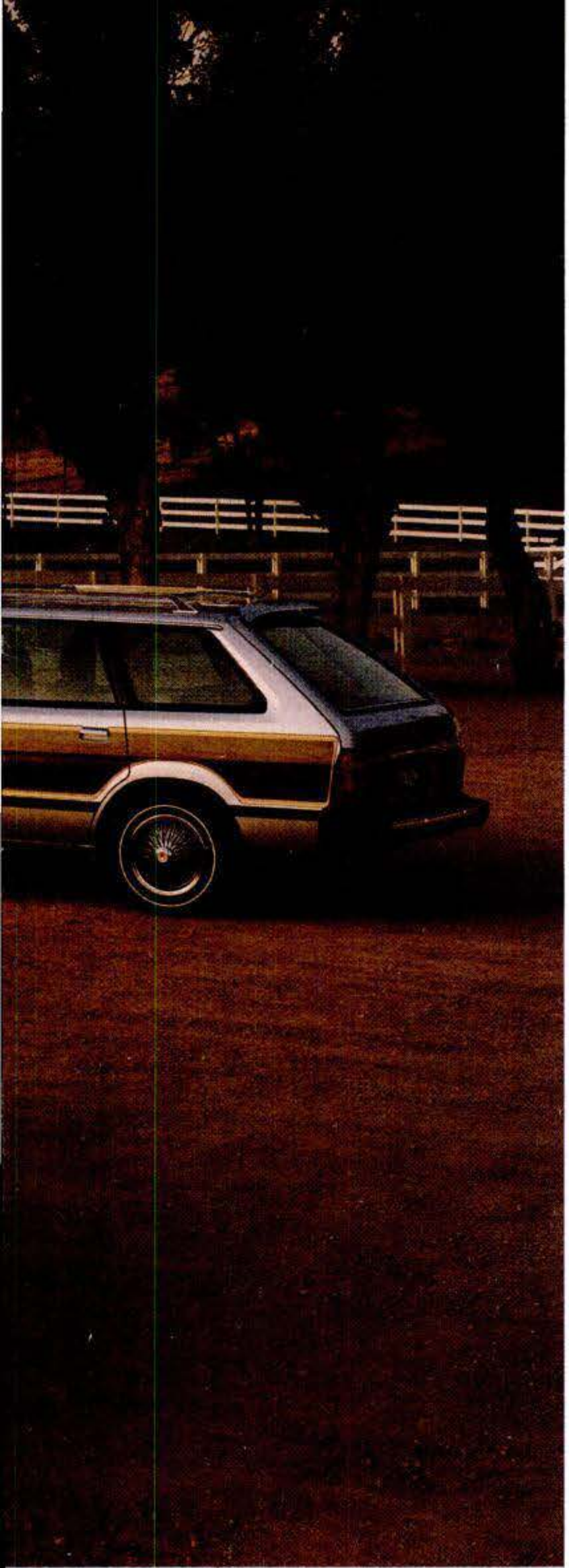
SR5



Subaru wagons (top left, model GL in foreground, DL in background) feature a unique aluminum-alloy horizontally opposed four-cylinder engine. Optional on GL models is a new digital speedometer and trip computer. Push a button, and it displays your fuel range and present consumption. Tercel SR5 wagon (left) has four-wheel drive. Its controversial styling is best described as functional. A high roof line yields not only the distinctive quarter window but lots of headroom and excellent vision. At right (top to bottom), Mitsubishi Tredia is slightly wedge-shaped to penetrate the air more easily. Note small rear-wheel openings, to reduce air turbulence. Nissan's Sentra coupe is the front-wheel-drive replacement for the 210; it features power-assisted front disc brakes. Mazda GLC Sport four-door has performance alloy wheels and steel-belted radials. Rear twin-trapezoidal link suspension provides straight-line stability, predictable cornering. Tercel SR5 Liftback scoots through a tight corner at 65+ mph.

provides quiet, economical highway cruising. The power range is just the ticket to surprise ersatz performance cars at stoplights. It's standard on all but the base Colt two-door hatchback.

Honda: Long known for building only staid, reliable, high-mileage sedans, Honda has finally succumbed to performance fever. The new Civic 1500 S replaces the GL and is Honda's answer to the demand for a low-price, sporty car. You can get it in any color as long as it's black or red. Other special exterior features include a front spoiler, dual remote-control mirrors, matte-black interior trim, and red-accented bumpers. Recognizing it will be easy, but staying with it on a twisty road may be difficult if the Civic FE's standard suspension package I sampled at the test track is any indication. Improvements under the skin include a rear stabilizer bar, recalibrated shock valving, and a lower final-drive ratio for better acceleration.

Honda's Civic 1300 FE will have the best EPA fuel-economy rating of any gasoline-powered car this year, with highway mileage of 59 mpg. Improvements come from slightly improved gear ratios, P-metric radial tires, and an upshift light.

Isuzu: In its diesel models, a new ceramic glow plug provides almost instant starts. The I-Mark diesel coupe has again secured itself a position on the EPA's top-10 list of mileage cars. The numbers are an impressive 44 mpg in the city and 54 on the highway. A new feature on the '83 Deluxe and LS models is a three-position tilting steering wheel.

Mazda: Like other import makers, Mazda hopes to strengthen its performance image by the addition of a sport model to the GLC four-door-sedan line. It will get a tilting sport steering wheel, performance suspension with front and rear stabilizer bars, and special interior treatment. All GLCs have received a new feedback-carburetor system for improved fuel economy. Exterior changes consist only of minor grille and taillight alterations. Ride will be somewhat improved by the use of softer rear trailing-arm bushings and rear shock-absorber adjustment. Mazda has also added an overflow coolant tank for the radiator. That will make servicing easier and extend intervals between radiator top-offs.

Mitsubishi: Until now, this Japanese builder supplied cars to Chrysler to fill out its small-car ranks. Now it steps out on its own into the U.S. market. The four-door Tredia is slick, not only visually but aerodynamically. Even the drip rails are recessed into the roof. Tredia's power plant is a four-cylinder, 1.8-liter (110 cu. in.) overhead-cam unit. It features the same Dual Engine Stabilizer system as the two more expensive models in the Mitsubishi lineup. The system involves two counterrotating shafts that cancel out inherent vibration in four-cylinder engines. The result is smoothness comparable to an in-line six or V8. Tredia has three valves per cylinder. The tiny third valve creates a swirl effect during induction that promotes more complete burning of the fuel. Buyers will have three transmission choices. A five-speed manual is standard. Optional are a 4+4 dual-range manual and three-speed automatic. The 4+4 allows the driver to choose between two sets of gear ratios about 30 percent apart. The taller ratio (2.967:1) is for economy. The other is for power (3.834:1). The change is made by moving a lever at the left of the transmission shift handle.

> "Civic 1300 FE will have the best EPA rating of any gasoline-powered car this year"

The automatic is a lockup type. A hydraulically operated damper clutch between the input and output shafts of the torque converter locks to prevent slip at low speeds. Although not the first unit of its type, Mitsubishi claims it's a more effective one because it operates at speeds as low as 12 mph. Tredia is one of the few sedans, at low or high cost, that provides rear-seat passengers with their own heating outlets. The front-door panels incorporate small pockets, and there are small trays under the front buckets.

Nissan/Datsun: Three of this maker's models fall into the economy group: Pulsar, Sentra, and Stanza. But the Pulsar, Nissan's replacement for the 310, is the real news for '83. Its radical, wedgy styling and pop-up headlights have already provoked a love-it-or-hate-it controversy. It's powered by a peppy 1.6-liter (98 cu. in.) four. Drivers can shift for themselves through a five-speed, or an optional three-speed automatic can handle the gear changes. And this sportster gets city mileage of 35 mpg and 50 on the highway, says the EPA.

Sentra, introduced last June, comes in two-door, four-door, and station-wagon configurations. According to Nissan, Sentra has 12 percent more interior volume than the tired 210 model it replaced. Using modern structural-analysis techniques and light, high-strength steels has trimmed the weight to 1,875 pounds. The diesel version of Sentra has a 62-mpg EPA highway rating.

Stanza is the roomiest model Nissan has ever sold in the U.S. Four passengers fit easily, and a fifth can be squeezed in if necessary. PS recently tested one at Bridgehampton Racetrack and it proved to be quicker from zero to 60 (13.4 seconds) and handled better than either a Honda Accord or VW Quantum [PS Nov. '82]. The reason: a new two-liter engine that features dual spark plugs, small valves, and dome-shaped combustion chambers for fuel efficiency. At the same time, these improvements ensure plenty of torque for good pickup. The engine is also one of the lightest for its displacement in the world.

Subaru: Engines will have more horsepower this year. Both the 1.6- and 1.8-liter fours are breathing better because of larger valves and valve-seat modifications. Models with automatic transmissions will also get hydraulic tappets that operate more quietly and won't require the periodic adjustments of the mechanical type. This year's automatics will also have a lockup torque converter for better mileage. Even four-wheel-drives will get the new feature.

Toyota: Starlet remains one of the few front-engine, rear-drive economy models. This year its tiny 1.3-liter (79 cu. in.) engine resides beneath a potent-looking electronic fuel-injection system. Why the elaborate induction setup? It's part of the continuing pursuit of better mileage and smoother performance. According to our track tests, it provides both.

Tercel has been revamped for 1983. The SR5 I drove at Bridgehampton Racetrack was one of the best-handling cars I've driven this year, and the tall sports seats provided excellent support in sharp curves. The second piece of news for Tercel fans is the addition of a 4WD wagon. It's been labeled an instant cult vehicle. Convinced of the wagon's sure-footed ability, Toyota includes an inclinometer to show pitch and roll axes for hilly, off-road driving. PS

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Resale value is only interesting if you're interested in reselling.

In 1977, this Honda Civic CVCC Hatchback was a remarkable value. But what's even more remarkable is the value it has today. After five years and 56,000 miles.

The engineering and workmanship are of such high quality you could sell this Civic for much of what you paid.*

But that's not so surprising. Honda Civics, Accords and Preludes have traditionally maintained a high resale value. Among the best in the industry. Which might help explain this next interesting bit of information.

Honda owners tend to stay Honda owners. It's as simple as that. As a matter of fact, Honda enjoys the highest owner loyalty among all leading import cars.**

And you can't put a price on loyalty.

*Nov./Dec. 1982 *Kelley Blue Book.* Price depends on car's condition, mileage, equipment, etc.

**Source: R. L. Polk and Co., 1981 model year *New Car Buyer Analysis.*

HONDA

We make it simple.

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Space-stretching design gives big-boat feel to **pocket cruiser**

PS's mini motor sailer telescopes for trailering, costs $800 to build

By SUSANNE and PETER STEVENSON
SKETCH BY EUGENE THOMPSON

This compact cruiser has a dual personality. Fully rigged, it's an honest sloop, easy to tack and nicely balanced in a blow. Strip off the spars, and the craft has the classic lines of a vintage powerboat. With a five-horse Mercury at cruise, it trots along at a sedate but usable five to seven knots.

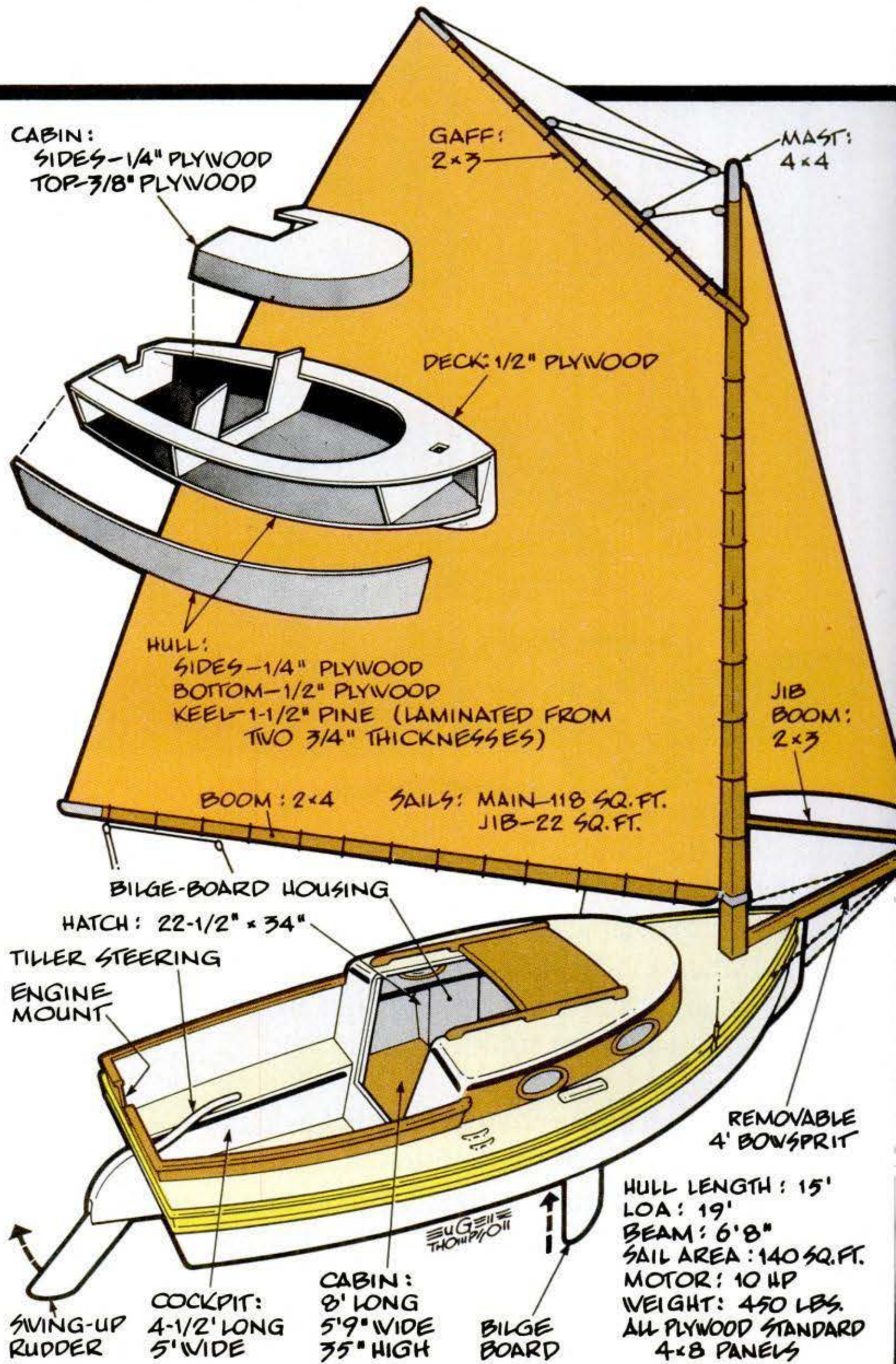
The mini motor sailer is a close cousin to the highly popular Weekender [PS, March '81]. Though easier to build and shorter to trailer than the original Weekender, the cruiser has twice the cabin room.

Unobstructed by a centerboard, the eight-by-5¾-ft. cabin is roomy enough to make overnighting comfortable, if cozy. And the pull-up bilge boards (see diagram, right) are easier to construct than the Weekender's centerboard.

Power options? A built-in engine mount takes up to a 10-horse outboard. Or attach the bowsprit and clubfoot jib—and you've got the sail rig of a 19-footer. To trailer, unhook the detachable bowsprit, and the 19-footer shrinks four feet. (See next month's issue for news about a compact trailer you can build.)

Standard lumber and plywood are used throughout. For low maintenance and extra strength, the entire boat is covered with a layer of fiberglass cloth and finishing resin.

Despite inflation, this boat costs the same to build as the Weekender—less than $800 for everything from mast-tip paint to carpets. PS



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Scooting along, the pocket cruiser's 140 sq. ft. of polyethylene sail catches the breeze (above). With sails removed, the craft evokes a classic motor launch (left). The comfortable cuddy (inset) has 35 inches of head room. For detailed construction plans, send a $10 check or money order to Stevenson Projects, Dept. M59, Box 584, Del Mar, Calif. 92014.

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Build extra living space

within your present walls

Part I

Use these techniques:

- a curved wall
- a partition of windows
- an ultra-thin deck

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CONSTRUCTION BY CHICK SGROI; PHOTOS BY GREG SHARKO

Here are fresh ideas to help you dramatically reshape your home

By RICHARD STEPLER
DESIGN BY JEFF MILSTEIN

It started out simple, as home-improvement projects often do. We wanted to divide a studio/work area from our dining area with a partition. But we soon realized that a single partition would not solve all of our space and storage requirements. In fact, unless we created additional rooms, we'd soon outgrow our home.

For a while, we experimented with plans of our own. But the designs always seemed less than adequate. Then we made our second smart decision: We commissioned architect Jeff Milstein to develop a complete interior redesign. These were our requirements:

- A master bedroom with closets and dressing area.
- A guest or child's bedroom.
- Two work areas, one for a graphic designer, a second for a writer-editor.
- Built-in shelves for a large collection of books.
- A walk-in storage closet.

In addition, since most of the space we were working with had no direct access to windows, daylighting and ventilation had to be carefully considered.

Along with his preliminary drawings, Jeff prepared a scale model of the project (photo next page). This helped us to visualize the new rooms and make changes before we actually started building. In fact, we modified the preliminary design quite a bit: There weren't enough closets, and the guest bedroom was too small.

As you can see from the final floor plans, Jeff created a multi-level set of interlocking rooms, all contained in an interior area that measures about 12½ by 24 feet. "It's like a Chinese puzzle," someone remarked.

Continued

When you're carving a new room out of an existing one, a curved wall lessens the impact of the intrusion. Hallway with entrance to dressing room is at left, walk-in closet is at right. Master bedroom (inset) is on upper level, behind curve. Half walls are topped with cherry wood.

In the style of shoji screens (facing page), this bank of four two-bay steel-casement windows with their translucent glass lets light and air into interior guest bedroom. Inset shifts view farther right to show entry and hall to bedrooms and studio. Guest's sleeping loft is above, behind the three-bay window.

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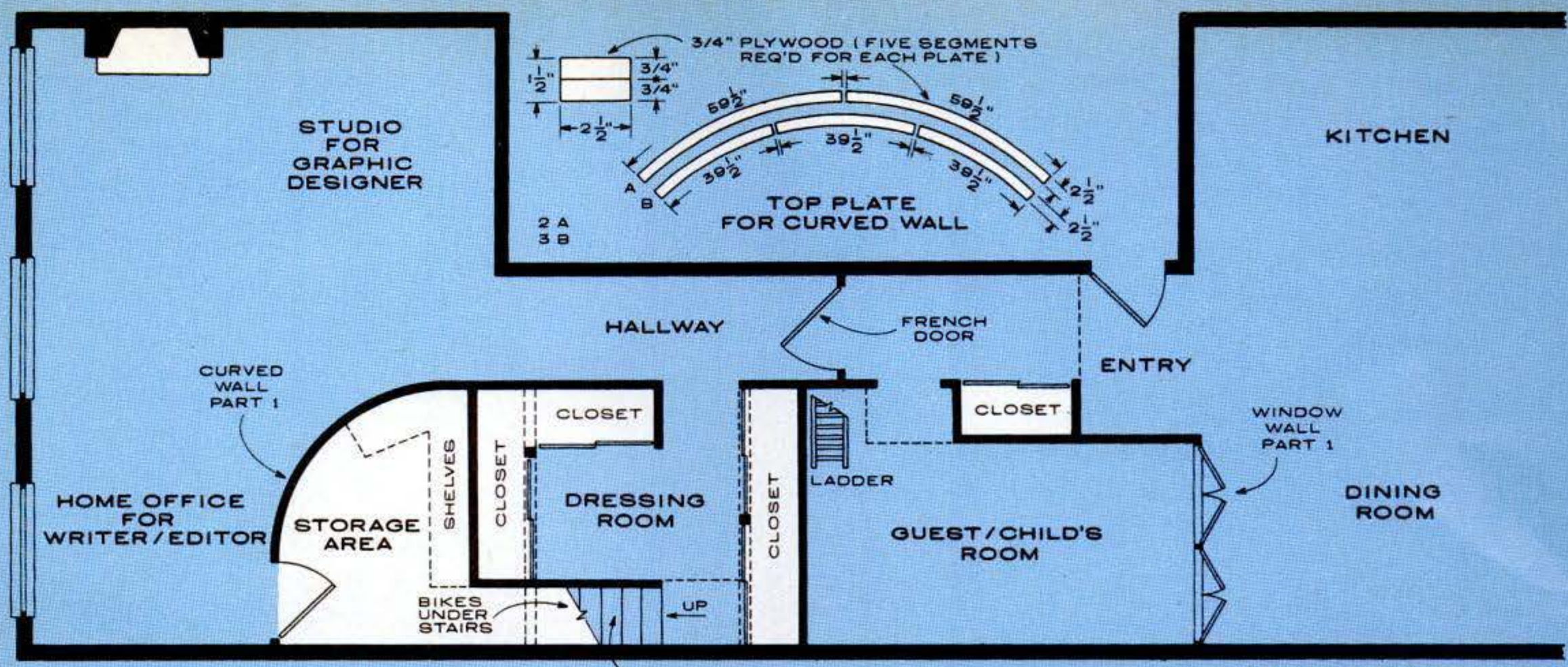
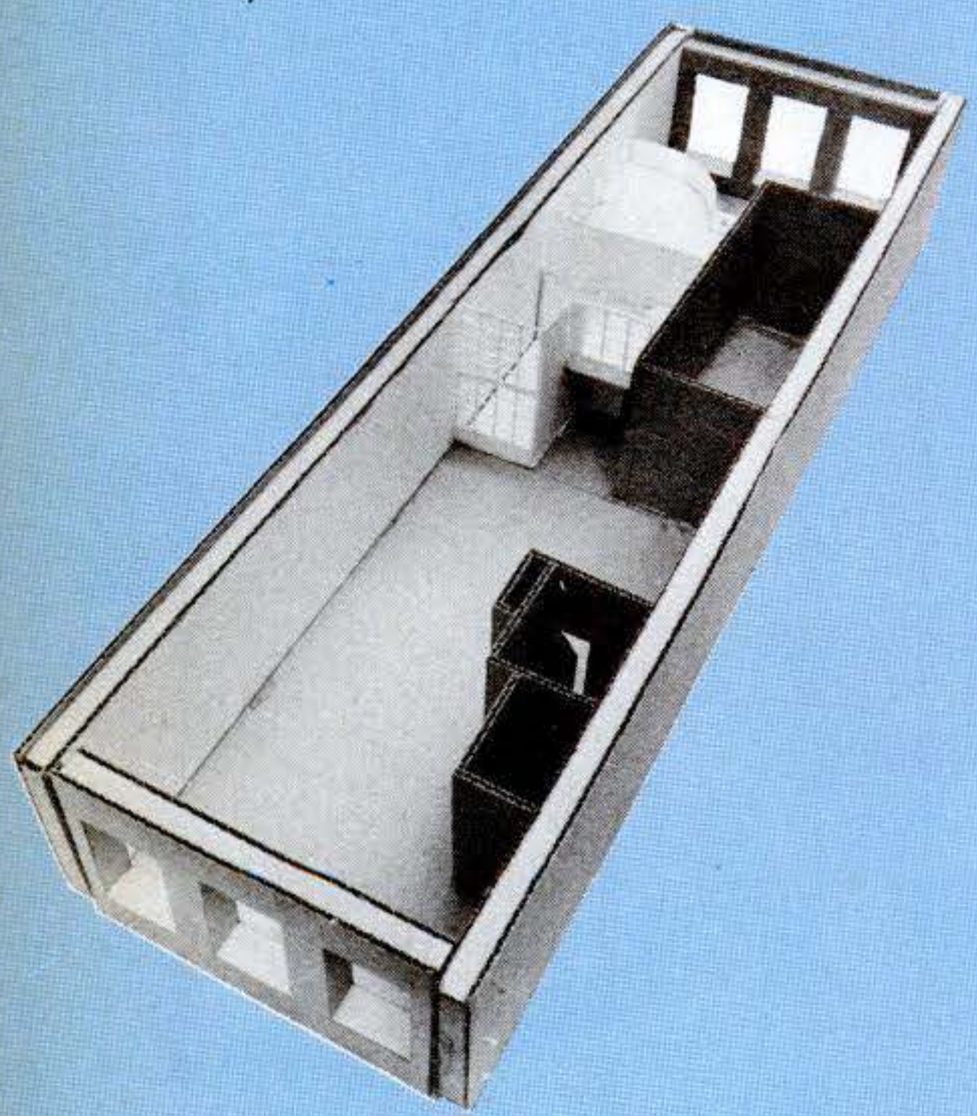
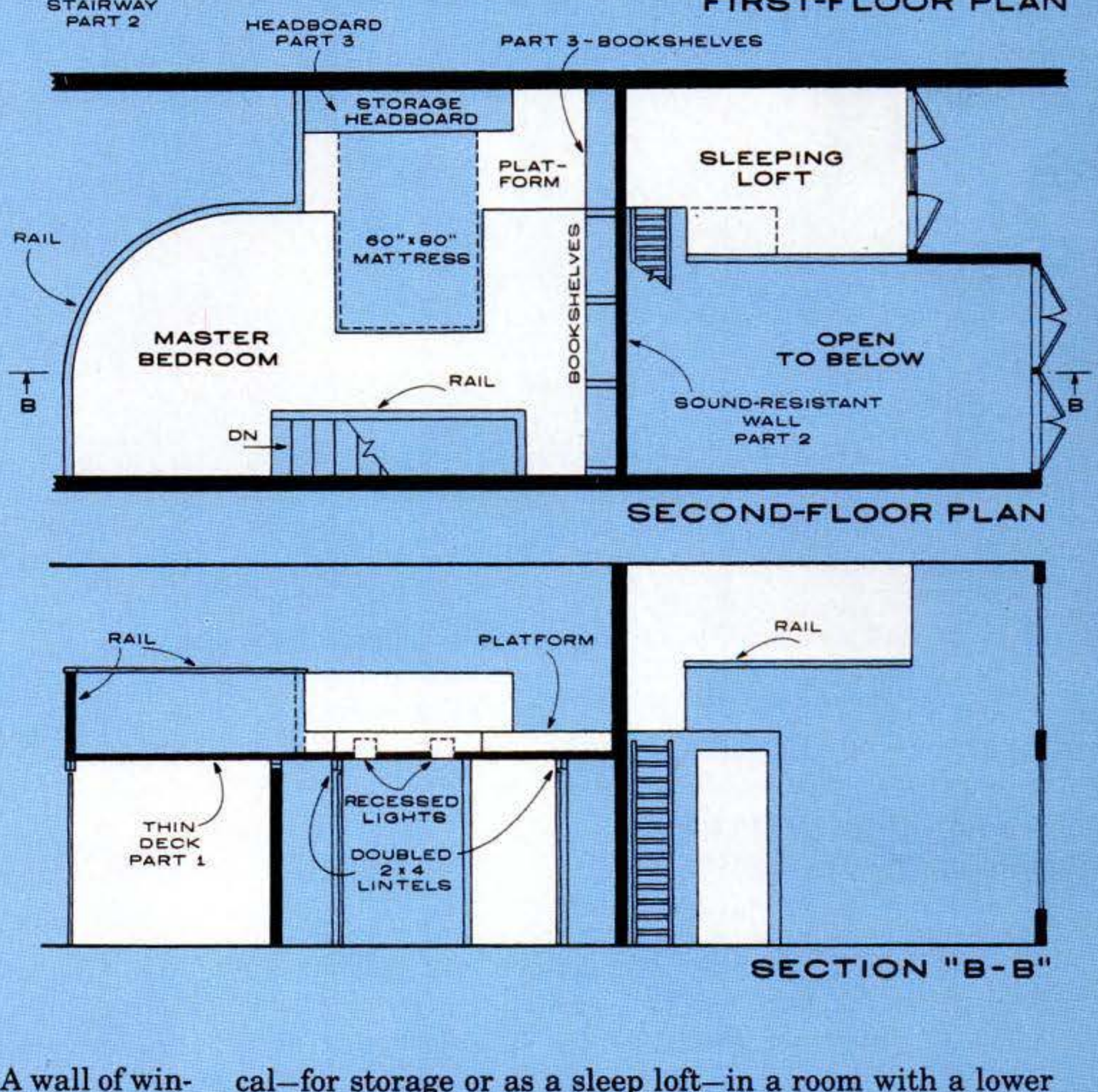


FIRST-FLOOR PLAN





SECOND-FLOOR PLAN

SECTION "B-B"

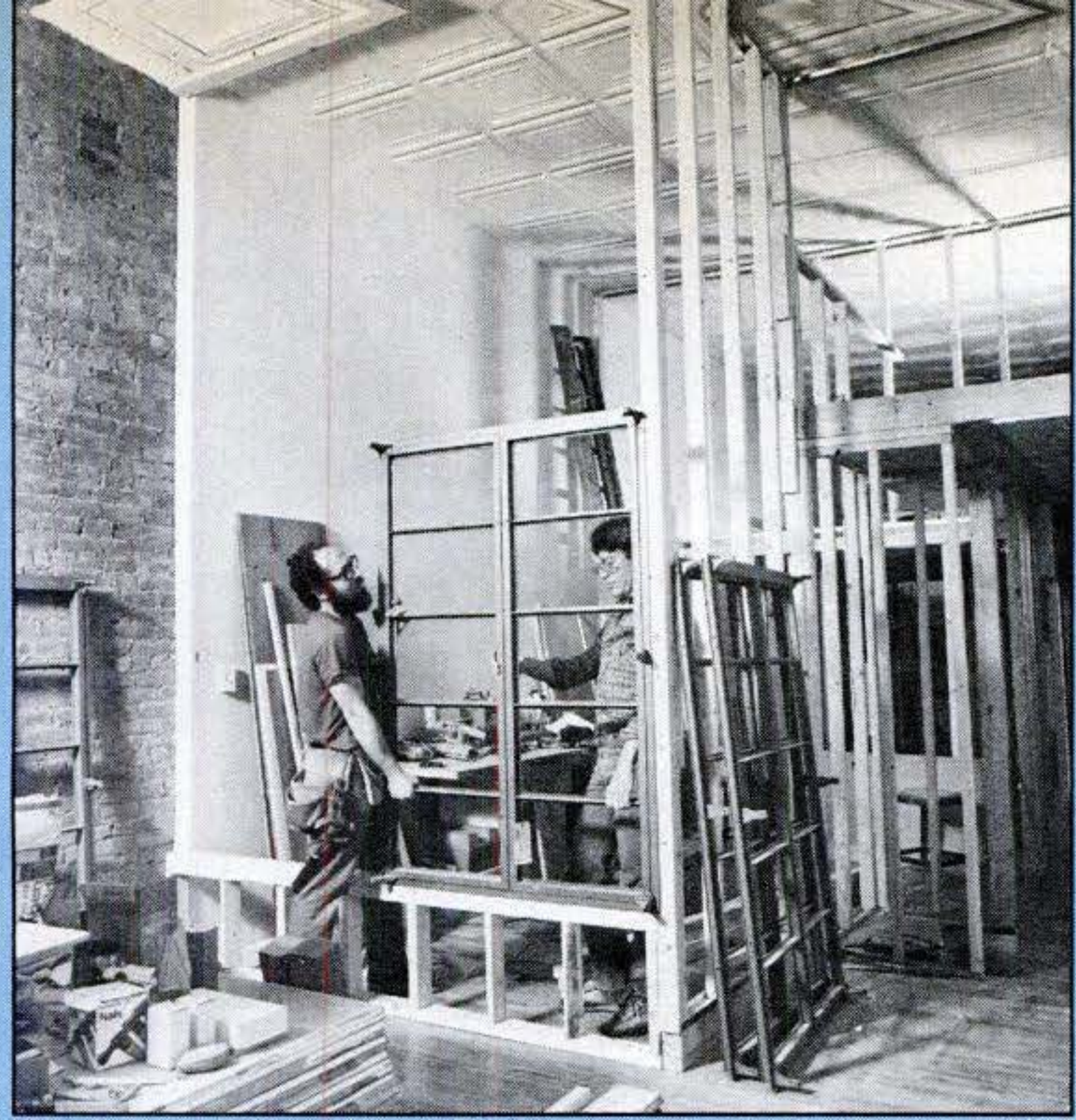
Drawings detail a multi-level project that interlocks like a Chinese puzzle. Top drawing shows sandwich construction of plates for curved wall. Cardboard scale model helped us avoid making changes after construction was under way.

We got everything we asked for and more: A wall of windows divides the guest room from the dining area. The guest room has its own sleeping loft atop a dropped ceiling in the entry, which boasts a coat closet. There's a dressing room with walls of closets for the master bedroom, which is reached by its own stairway. This room overlooks the studio, which is reserved for our work areas. Under the master bedroom: a generous walk-in closet. We got a wall of bookshelves and a sound-resistant wall between the two bedrooms. And not a square foot is wasted: Bicycles go under the stairway, and the dressing room's recessed lights go into the space beneath the platform bed.

While our project was designed for a full floor with 12½-foot ceilings in a 100-year-old cast-iron loft building-turned-residential-condominium, many of the ideas and construction techniques we used could be adapted to your own home-remodeling projects. This article shows you tricks for faster framing; how to construct a curved wall; how to build a partition of windows; and how to install an ultrathin deck that might just make a second level practical—for storage or as a sleep loft—in a room with a lower ceiling than ours. Next month I'll show you ways to build stairways and sound-resistant walls, plus lighting tips for low ceilings. Finally, in Part 3, I'll detail construction of built-ins for the master bedroom.

We began by drawing chalk lines to mark the location of first-floor walls. A fast way to frame partitions is to use metal channels as bottom plates. Screw the channel to the floor and then pop studs in one at a time, fastening each with two screws, one driven from each lip of the channel. (A screw gun is an essential tool.) We used wood studs and top plates—doubled in most walls—for the strength needed to support the deck. To save space, we used 2×3 studs throughout most of the project.

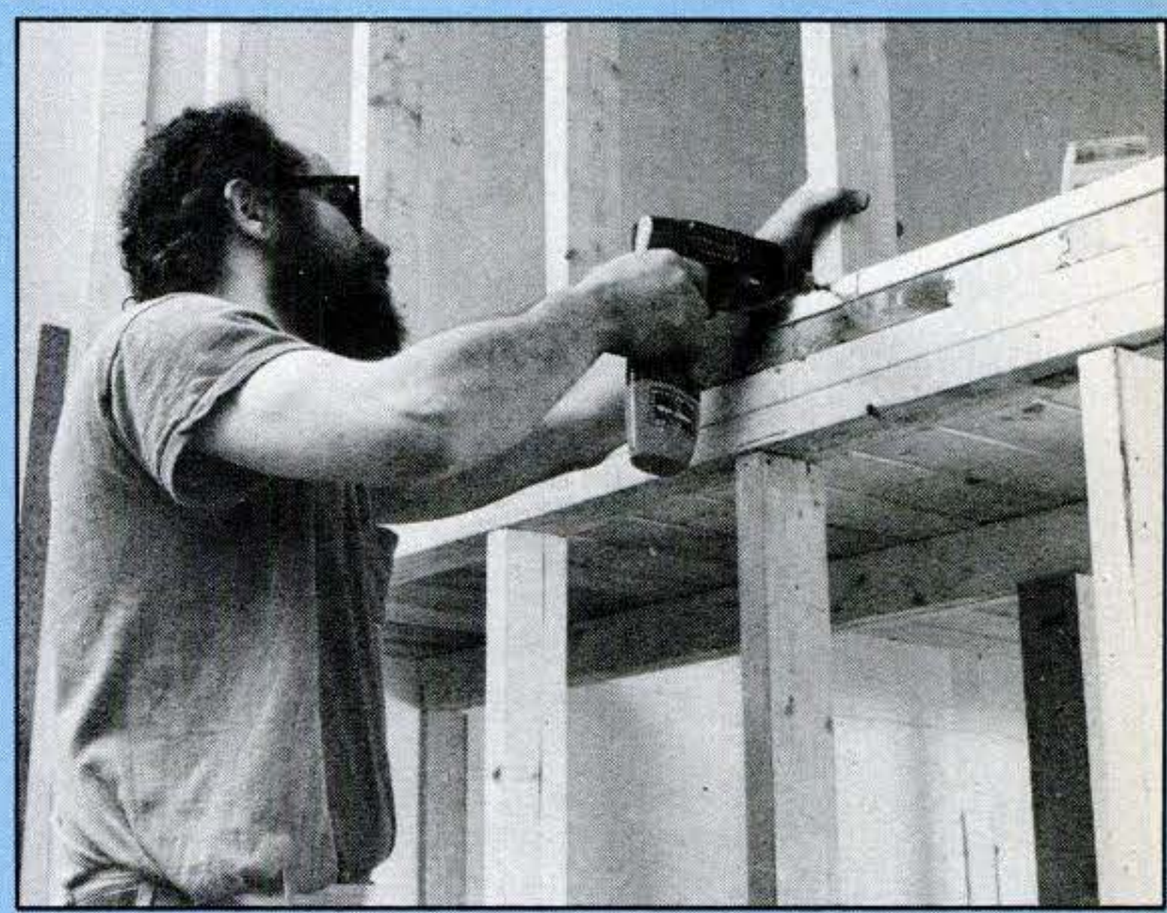
We used a six-foot-long string to mark the location of the curved wall's bottom plate. Then we temporarily tacked strips of ¾-in. plywood to the floor and scribed the same curve on them. These were removed, cut, and assembled for top plates (see drawing and photo for details). We cut the channel almost through with a carbide saw blade ev-



Window partition rests on 2×4 knee wall with doubled top plate; studs are 12 inches on center. Author is double-checking casement windows for fit after the framing was completed.

Curved plates are sandwiches of five segments cut from ¾-in. plywood (see drawing, facing page). Skil's Sand Cat belt sander smooths edges once segments have been glued and screwed.

Framing for the curve: 2×3 studs are oriented radially. Decking is nailed to curved top plate. Note higher hallway headroom with conventional 2×6 joists to support the ceiling.



Studs were screwed to metal channel plates. Skil's cordless Boar Gun makes working on a large project easier (no snaking extension cords). Note doubled top plate and t&g decking.

ery five inches and then screwed it to the floor along the chalk line. Studs for the curve are 12 inches on center; we determined where gypsum-board joints would fall and used doubled studs at those points. Finally, we nailed on the top plate.

We used ⅜-in. gypsum board horizontally, and applied it dry—without first wetting or dampening it. We first nailed one end firmly to the starting stud. Then we *slowly* bent the sheet around the curve, nailing it at each stud as we went. We lapped two ⅜-in. layers on the outside of the curve for strength. Tips: You'll need two people—one to bend, the other to nail. Be sure to use lots of nails. And finally, when it comes to spackling and finishing the joints, use lots of compound.

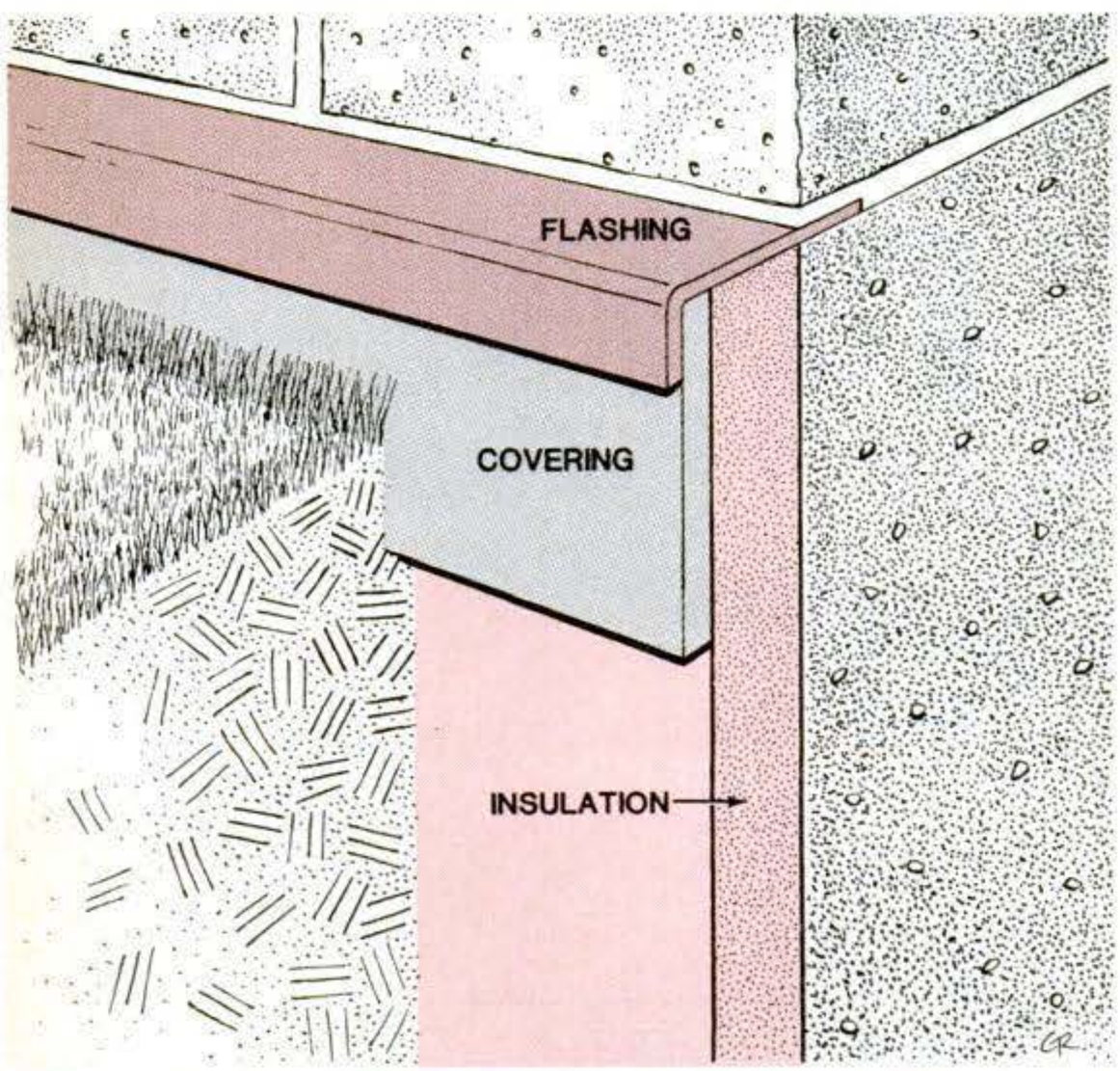
Our plans called for stock-size steel casements for the window partition. ("Custom-size frames would cost you a bundle extra," Jeff noted.) The windows rest on a reinforced knee wall—2×4's 12 inches on center with a doubled top plate. Because of ceiling height we stacked the windows two high, with a doubled 2×4 beam between them. The windows are secured to the surrounding wood framing by four-inch screws. The most difficult part of the job? Lifting the heavy steel casements into place. After they were installed, we glazed them with Factorlite, a translucent glass that's patterned on one side.

To preserve headroom, Jeff devised a tongue-and-groove deck that takes up only 1½ inches of space. For a 12-foot-six-inch ceiling, that leaves six feet two inches-plus for each level. "The 2×6 t&g decking will just support the loads if no span exceeds seven feet," Jeff advised. Besides the doubled top plates of first-floor walls, two doubled 2×4 lintels support the decking. The lintels keep maximum spans within specs.

We installed the decking one piece at a time, snugging each joint as tightly as possible. Hammering blocks of scrap decking are essential to avoid damaging the t&g joints. We face-nailed the boards with two 16-penny nails at each support. The "finish" side of the decking faces down; it's the ceiling for the first floor. Gray industrial carpeting covers the top. PS

Insulate the *out*side

to cut heat loss through foundation walls



Sketch at top shows facing panel that protects insulating board from sun exposure and impact. Covering panel should project two inches below grade; buried part of insulation needs no facing. Metal flashing, inserted into grout line, caps top. Photo shows pre-coated board attached with nylon anchors.

Seal in heat and save money by skirting the outside of your foundation with weather-protected rigid foam

By MARK BITTMAN

Once you've insulated your attic, installed storm windows, and weatherstripped or caulked every opening in the skin of your home, the next step is to insulate your foundation.

Heat loss through foundations, which may be relatively insignificant in uninsulated houses (usually under 10 percent of the total), becomes a major factor in well-insulated structures, where 15 to 35 percent of the heat still lost escapes through concrete foundations. That's not surprising when you consider that eight inches of concrete rates an R-value of just over one, little higher than that of glass. Worse yet, concrete acts as a wick, collecting heat from lower portions of the house and passing it to exposed, above-grade areas of the foundation.

Is foundation insulation worth it? Based on calculations with ASHRAE formulas, a four-foot depth of four-inch-thick polystyrene (with two feet of the foundation exposed and the boards rated at R-4 per inch) would save $302 per year in Boston, assuming a basement temperature of 65 degrees F and oil heat at a low $1.20 a gallon. If a home's perimeter is 150 feet and we assume an insulation cost of $1.50 per square foot (a high estimate), the cost of the insulation job is $900, giving a three-year payback period. In other climates, the payback period may range from as little as a year and a half to about six years, depending on your type of heat.

Before starting the project, you must decide whether to use extruded polystyrene, such as Dow's Styrofoam (U.S. Gypsum makes a similar product called Formular), or one of the expanded-polystyrene (EPS) products, manufactured by perhaps 150 different companies. Although Styrofoam has a higher R-value (R-5 per inch of thickness compared with R-3.5 per inch of expanded polystyrene), it's twice as expensive (about 30¢ per board foot compared with 15¢ for EPS).

Both kinds of rigid board must be protected from impact and UV radiation. Both also expand and contract significantly due to temperature changes, so any covering must be either flexible enough to tolerate these changes or tough enough to provide restraint.

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Typically, a mixture of a portland-cement matrix reinforced with chopped fiberglass, plus an acrylic or acrylic-latex bonding agent, makes a covering hard enough to withstand hammer blows and limit board movement. But since the panels still move under any covering, expansion joints should go every 12 feet or so.

You could, of course, cover the exposed insulation with cement board, exterior plywood, or other weatherproof panel, as shown in our sketch, but an applied coating is still cheaper. You can buy pre-coated insulating panels—practical if much of your foundation is above ground. These are made by Conproco, W. R. Bonsal, and Thermboard. They save time and work, but the coating may not be as thick as one you'd apply yourself, and the overall cost could be nearly double. You don't have to coat the part of the board below grade, so it may be worth it to buy unfinished panels and trowel on a coating only where needed.

Once you've decided which material and technique to use, you'll have to determine how much insulating board you need (it's usually sold in panels that measure two by four feet or two by eight feet). This decision depends on how far below grade you want to go. Two feet of insulation below grade greatly reduces heat loss by preventing the concrete from wicking heat up above ground level and out into the air. Insulating all the way to the footing increases energy saving another 10 percent or so, but you may not feel that's worth it, especially if you have to dig an additional six to eight feet.

After digging the trench you must measure, cut to size, and miter panels (where necessary). Cut the pre-coated panels with a circular saw equipped with a masonry blade; cut uncoated board with a utility knife, hacksaw blade, or fine-toothed crosscut saw.

The panels may be installed either by mechanical means or with a mastic. Expandable nylon anchors work well, but drilling four to six holes per panel into masonry can get tedious.

Choose a mastic that's compatible with your insulation—such as Dow #11 for Styrofoam. You can apply it in walnut-size dots (avoid the tendency to use too little), with a serrated trowel (a lot of work), or in ribbons (a good compromise). Tacking time is generally about two minutes. Prop the panels in place while the mastic sets.

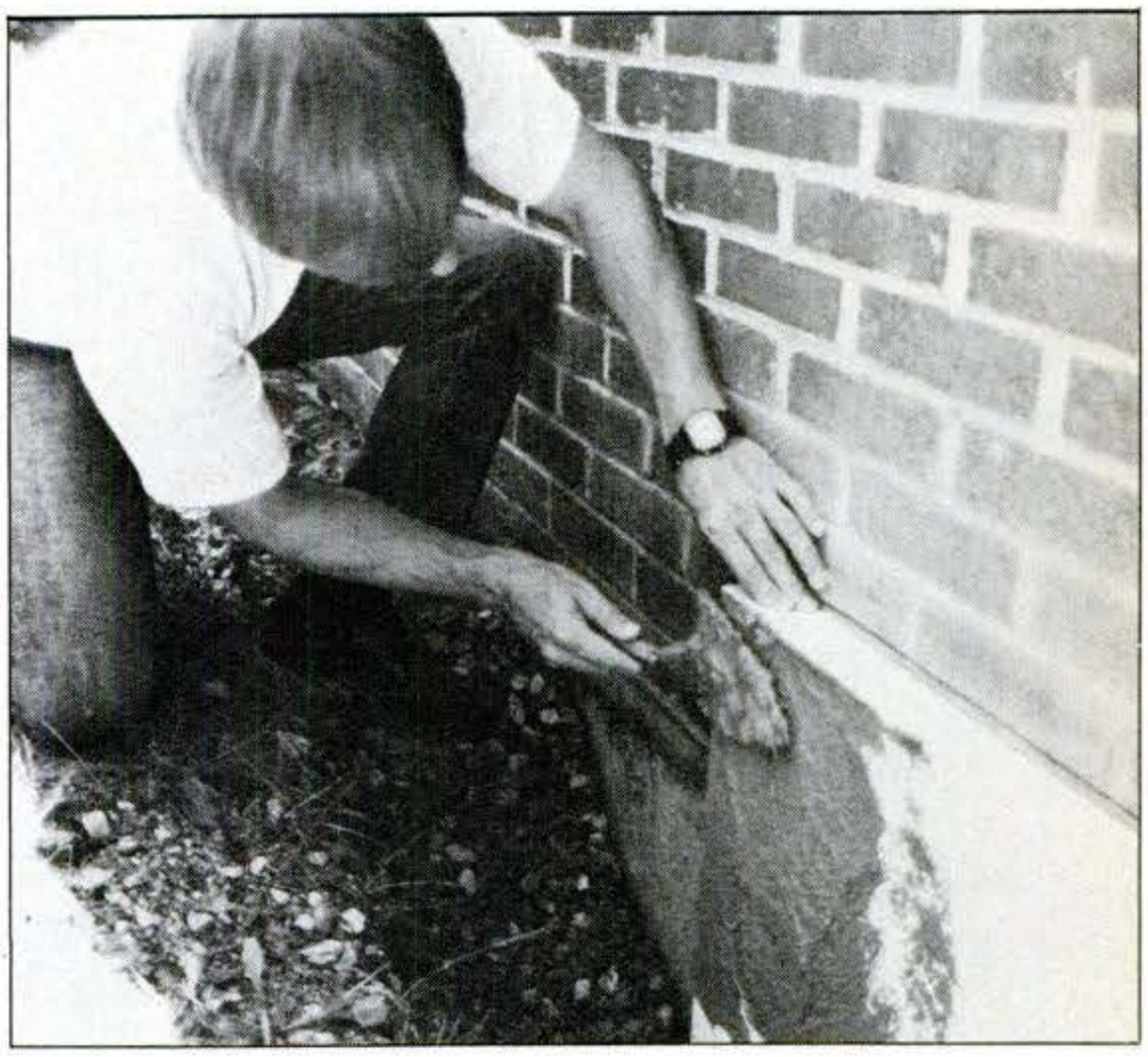
Once set, the boards are ready to be coated. The compound used in the job pictured was supplied by Conproco, and is made by mixing a bag of its Structural Skin (cement-fiberglass mix), a gallon of its K-88 (latex acrylic), and about a quart of water (the compound doesn't come pre-mixed). The final consistency resembles that of soft ice cream. The coating should be applied with a trowel to a thickness of ⅛ to ¼ inch. It should cover all the exposed board, down to about two inches below grade.

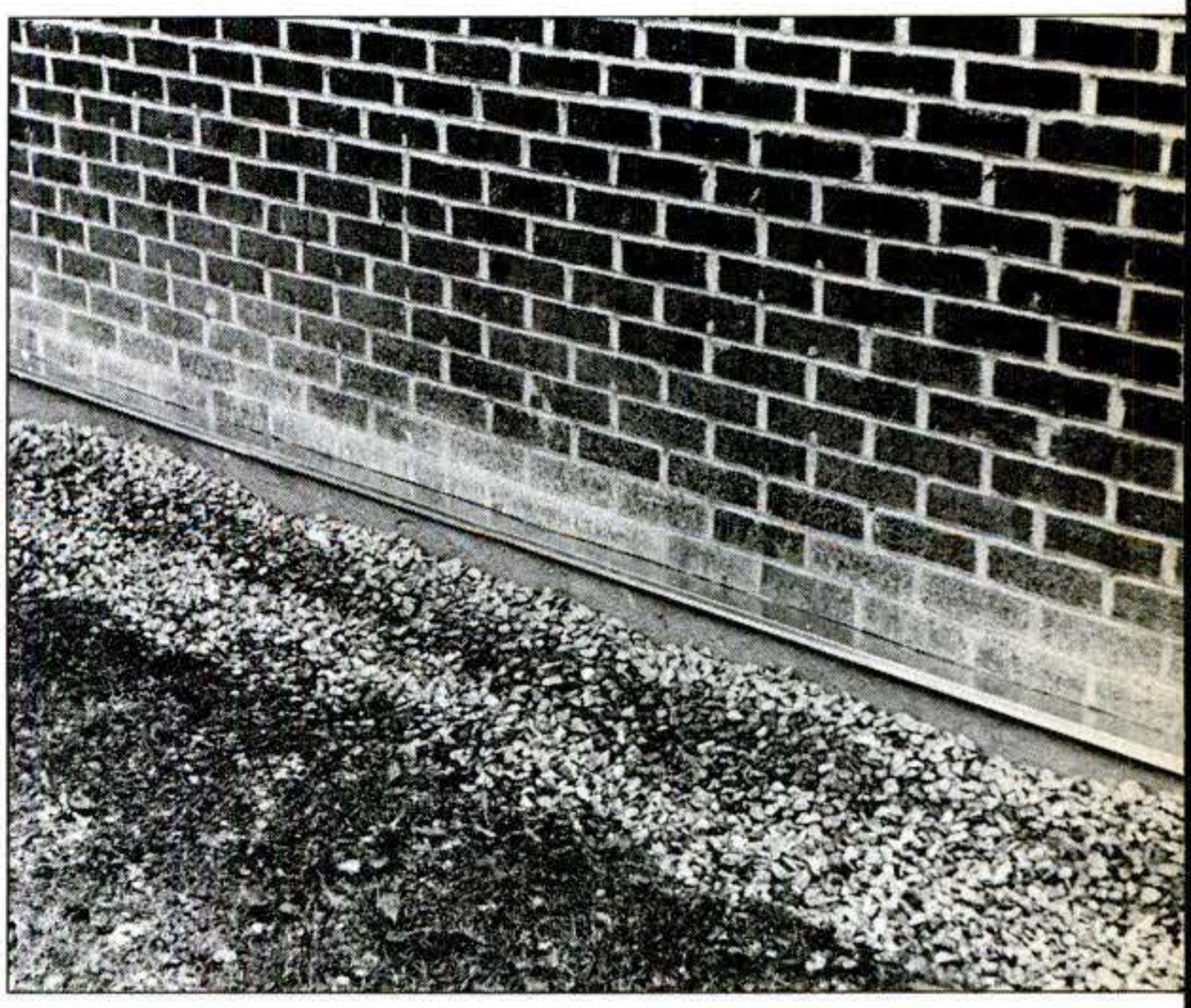
You make expansion joints by installing—before troweling—pre-manufactured thin-coat stucco control joints (available from Plastic Components of Miami), or by simply scoring the still-wet surface coat with a trowel.

You can leave the protective layer with its natural stucco finish; it's a visual improvement over most unfinished foundations. But, if you prefer, you can choose from a variety of finishes, including factory-blended finish stucco or any breathable latex paint suitable for masonry. PS

MANUFACTURERS OF INSULATING PRODUCTS

Coating products: W. R. Bonsal, 8201 Arrowridge Blvd., Charlotte NC 28224; **Conproco Corp.,** Box 368, Hookset NH 03106. **Expanded polystyrene: Amotex Plastics of Maryland,** 1127 S. Howard St., Baltimore MD 21230; **Insulair, Inc.,** Rte. 6, Box 228, Gainesville GA 30501; **Plymouth Foam Products,** 1800 Sunset Dr., Plymouth WI 53073; **Texcon Products, Inc.,** Box 4154, Houston TX 77210; **Vertex, Inc.,** 4200 Charter St., Vernon CA 90058; others. **Expansion joints: Plastic Components of Miami,** 7570 NW 79 St., Miami FL 33166. **Extruded polystyrene: Dow Chemical Co.,** Styrofoam Products Dept., Midland MI 48640; **U.S. Gypsum,** 101 S. Wacker Dr., Chicago IL 60606. **Mastic: Dow Chemical Co.** (address above); **H. B. Fuller Co.** (Maxbond), 315 S. Hicks Rd., Palatine IL 60067. **Pre-coated boards: W. R. Bonsal** (address above); **Conproco Corp.** (address above); **Thermboard Mfg. Co.,** 1909 Lomas Blvd. NW, Albuquerque NM 87104.





Trial-fit the elements of the system (top) before doing final lay-up and installation. At center: Trowel coating onto unfinished panels to thickness of ⅛ to ¼ inch after mastic has set (or after fastening boards in place mechanically). Above, finished job, with gravel backfill and flashing in place.

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Fast-setting drywall compound lets you **tape like a pro**

Array of taping knives, mud pan, adhesive mesh tape, and sanding screen surrounds sacks of 20- and 90-minute hot mud.

Now, even first-time tapers can finish drywall flawlessly

By MARK LEE DUE

Taping drywall is one of the toughest do-it-yourself jobs. Few homeowners have the proper tools and materials to do the job right, to say nothing of know-how or experience. And the best place to experiment is not on your living-room walls, where every crack, blister, nail hole, and tape line becomes a daily source of regret and irritation. That's why most homeowners turn to drywall professionals like me to do the job.

That's fine for big projects, but you may not want to call in a pro for small jobs—finishing a basement, remodeling a bath, or just repairing a damaged wall. I believe it is possible for first-time tapers to get good results using a type of drywall cement that shrinks very little and dries quickly to a hard, durable finish. Used with some other drywall-finishing products that may be unknown to nonprofessionals—fiberglass-mesh adhesive tape and screen-type backless sandpaper—the fast-setting compounds enable the average home handyman to finish drywall without any noticeable imperfections.

The cements I'm referring to, polyindurate compounds, aren't all that new, but manufacturers have finally overcome the lumpiness and other inconsistencies that plagued past formulations. In the trade we call these compounds hot muds, because they give off mild, chemically generated heat when they are mixed. For pros, their main advantage over vinyl-type cements is that they set quickly, which means that jobs requiring two, three, or more coats can be completed in one day instead of three. That may also be an advantage for do-it-yourselfers, but hot mud's low-shrink quality is even more important. With vinyl, it is necessary to overfill drywall joints and to feather out the edges to allow for shrinkage. This is where most people go wrong, leaving too much or too little mud and slopping up the joint. You don't overfill with hot mud.

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Because they have been used almost exclusively by professionals until now, hot muds have generally been available only in 25-pound bags from building-supply stores. Now some makers are packaging the powder in four- or five-pound packages in consumer outlets. There are many brands, including Fast Set, Quick Set, Rapid Bond, Durabond, Sudden Bond, and Sta Smooth. These are made in a variety of setup times, ranging from 15 minutes to four hours; the most common are 90-minute muds. There are also exterior types. Pros may use different types of mud for first-coat and finish work, but a handyman can get by perfectly well with a single mud (90 minute or slower) mixed to differing consistencies.

The art of mixing

Proper mixing is crucial. Otherwise, you get a lumpy mud and disastrous results. Here's the right way: Put clean water in a clean bucket and pour in the powdered mud, mixing as you pour and not allowing the powder to sink to the bottom. Mix quickly to a stiff consistency, let the batch sit for a few minutes, and then remix and add water to reach the final consistency.

Different jobs require muds of different consistencies. For metal corner bead and on flat joints (both tapered board edges and full-thickness butts), you need a thick mix that clings to your taping knife. For the second coat, the mix should be softer, but not so it falls off the knife. For flattening uneven areas, taping angles (inside corners), or spotting (filling) nail holes, use a soft mix that drops off the blade. As little as one-quarter cup of water will change a bucketful of mud from one purpose to the next.

The reason a softer mix is needed for finish, spotting, and angle work is that mud stiffens considerably when worked. Those jobs involve more knife work than first-coating, in which you get rid of the mud in a single pass. When doing these jobs, make sure the mud doesn't start setting up in the pan. If a batch does begin to set prematurely, it can at first be washed away with spray from a garden hose. Later on, it will have to be chipped and scraped clean.

As important as having the proper mix is using the proper tools. Most do-it-yourselfers err by using the six- or eight-inch knives they happen to have around. A 10-incher is the only knife to use for flat joints and spotting. For angles, you need a six-inch knife; for feathering out on butt joints, a 14-inch may be needed. Use only straight knives, not the offset-

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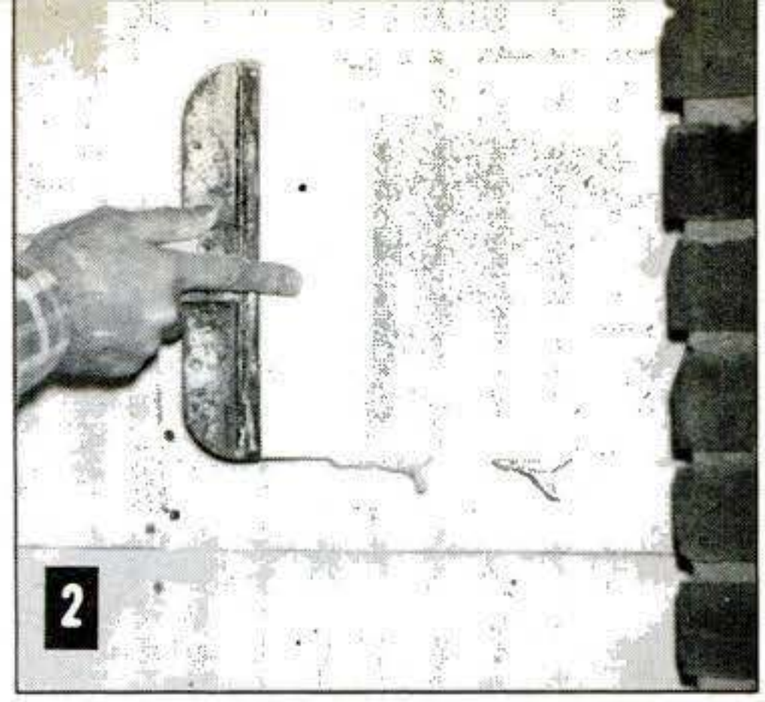

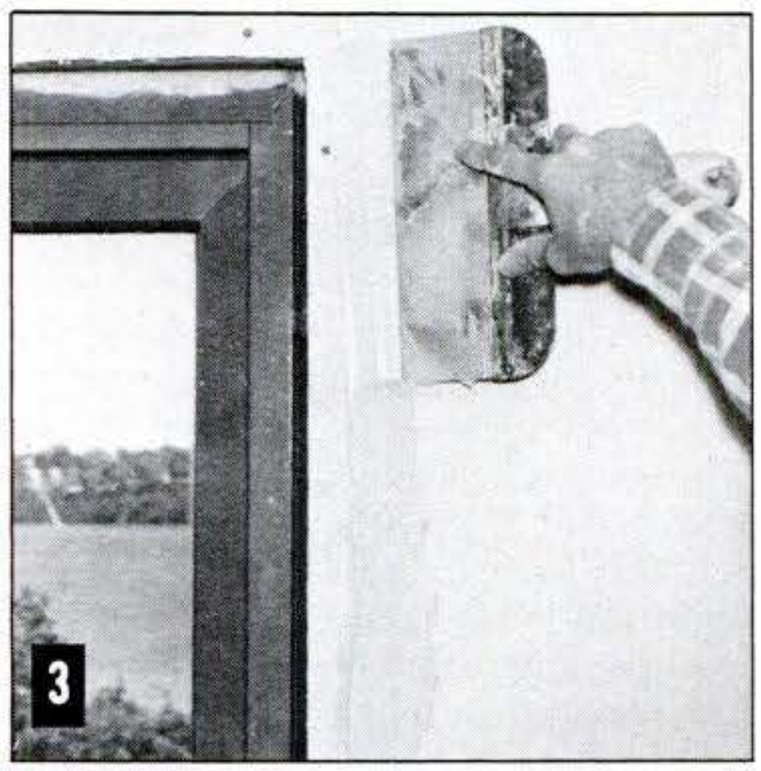

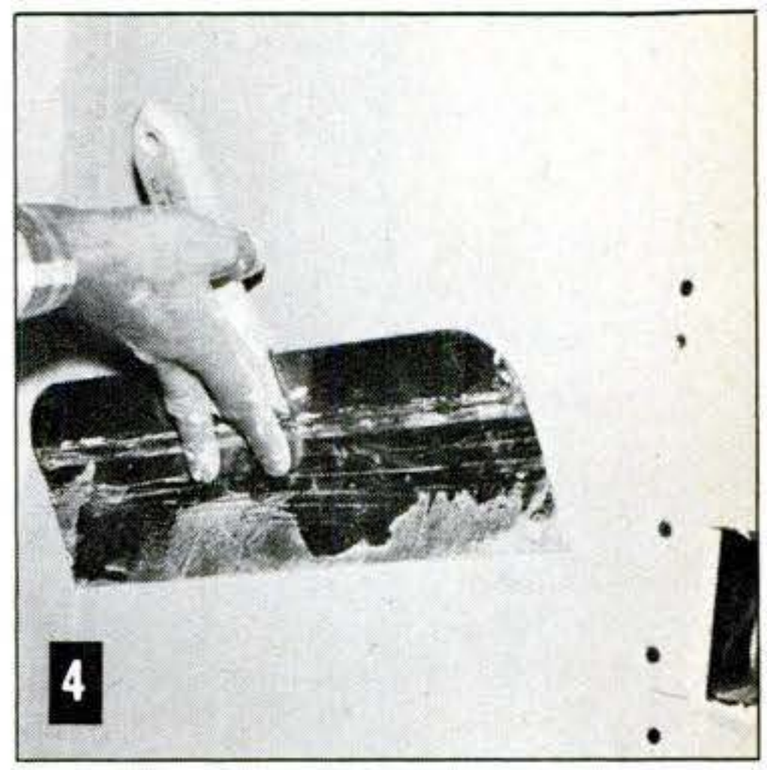

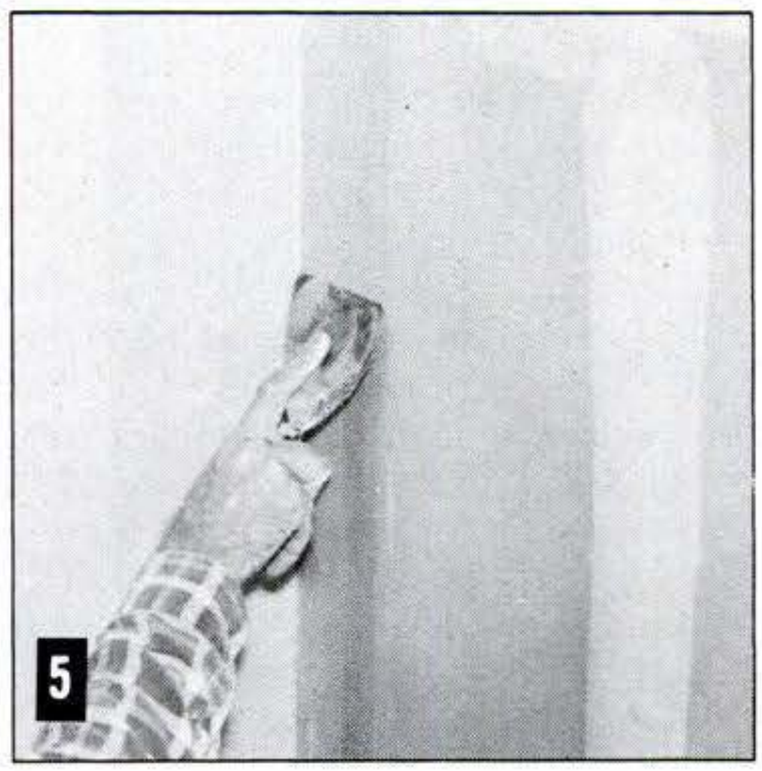

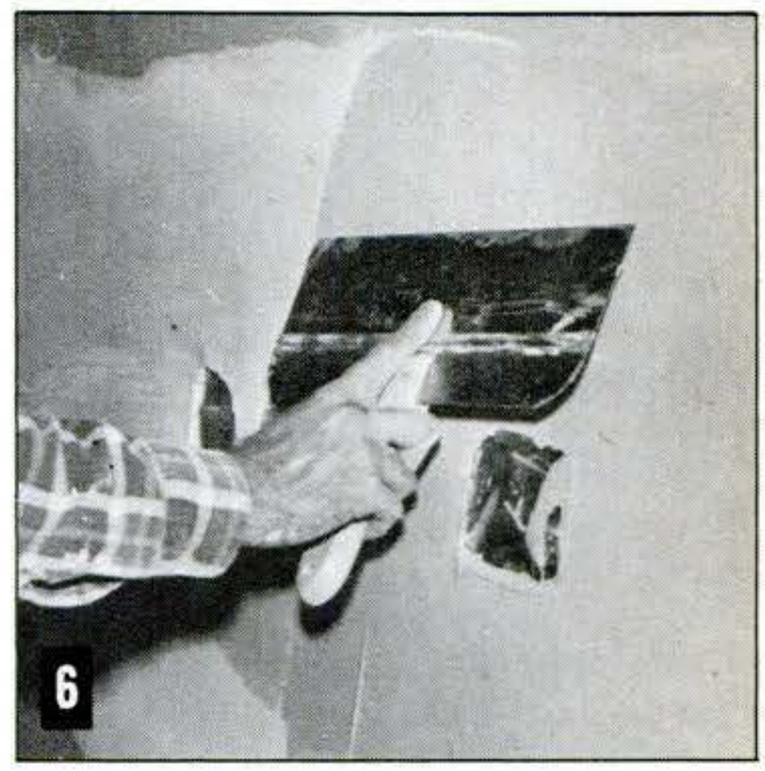

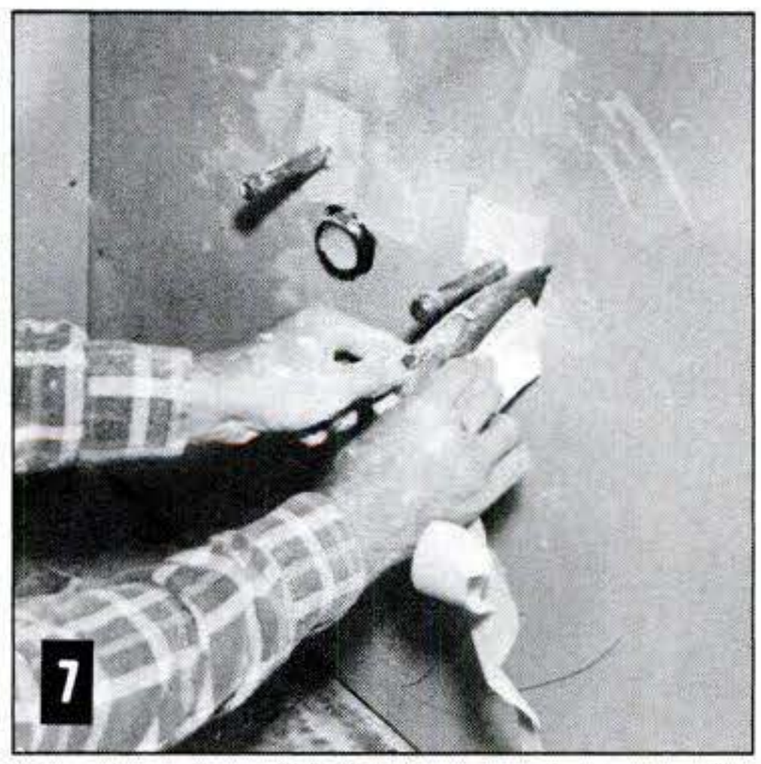

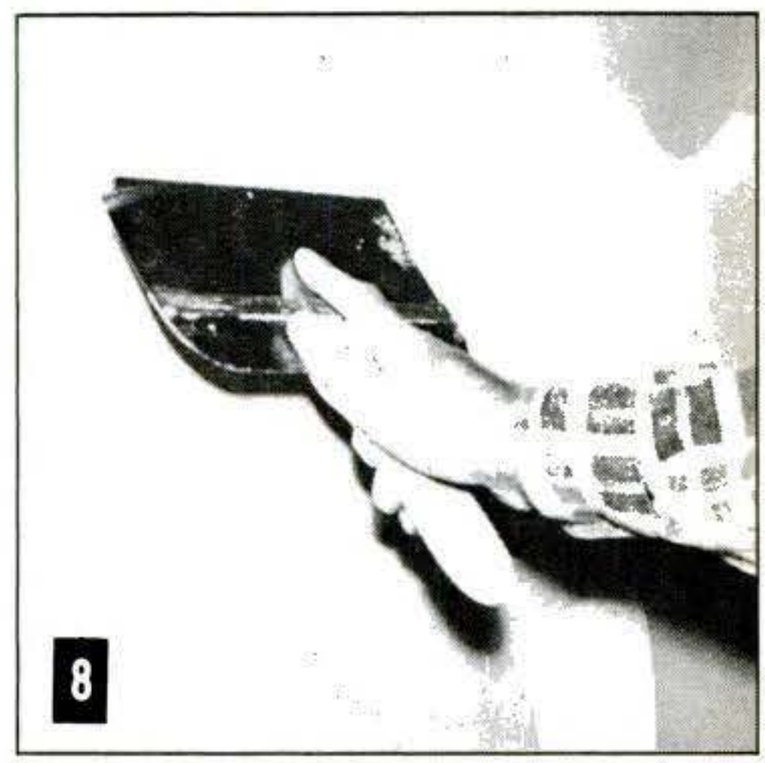

Step by step: (1) String mesh tape with the thumb-to-thumb method on all flats, but don't overlap at the joint intersections. (2) There's no pressure exchange when coating on flats; forefinger is held straight out. (3) Spotting requires a swirling motion. Here, taper is finishing stroke with finger pressure after starting with thumb. (4) Use two-finger pressure for first-coating butts, leaving as little mud as possible. (5) Use six-in. knife in angles only—for bedding, scraping, and smoothing (shown). (6) Tape around electrical boxes, then coat over with hot mud. (7) Don't use tape scraps around pipes; tear semicircles out of folded paper tape in paper-doll fashion. (8) Knife blade should spring when touching up blemishes.

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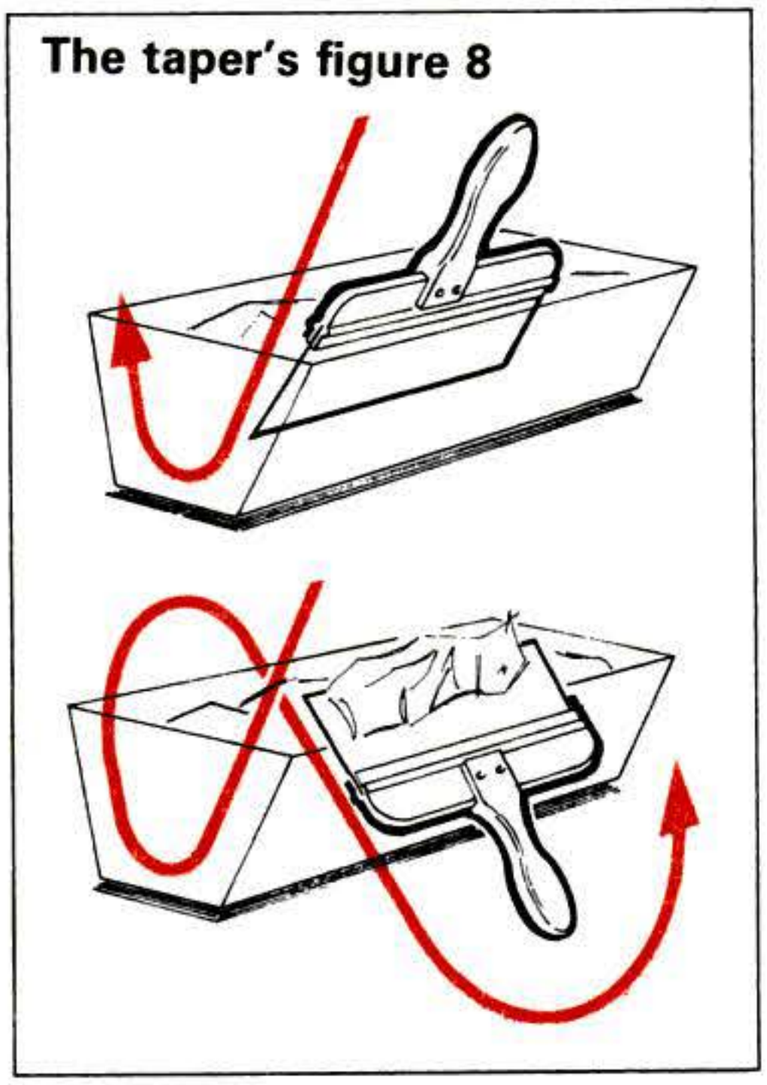
The taper's figure 8



To draw mud from pan, put knife point between mud and metal (inserting whole edge risks nicked blade), dig across and up, then wipe back against pan's lip.

handle contraptions with concave blades.

One other ingredient goes into a quality taping job: proper technique. That includes everything from how the knife is held to how much mud is removed from the pan to the strokes used to apply it to the wall. Journeyman tapers take months perfecting the special shoulder, back, arm, wrist, and finger motions needed to do the job effortlessly and quickly. But since do-it-yourselfers don't need a pro's speed, they can pick up sufficient skills with just a little practice.

The first and most important motion to learn is the correct way to draw mud from the pan—what I call the figure 8. The idea is to pack the mud on one side of your knife and leave the other side clean. Study the drawing above, and practice the repeated process of digging in, pulling up, and wiping back until it becomes second nature.

Now that your knife is loaded, you are ready to begin running angles and flats, spotting, and touching up. Each of these procedures calls for different strokes, but the knife is always held the same way: with the middle, fourth, and little fingers wrapped around the handle and the thumb and forefinger pushing on the blade itself, not the rib. (Some tapers put the middle finger on the blade, as well.) In this position you are ready to exert either thumb or finger pressure as the task requires.

Everything I've said about technique applies equally to hot mud and vinyl. But there's one important difference. When applying vinyl cement, the knife is held at a low angle to the wallboard to allow the blade to bow and overfill the joint. With low-shrink hot mud, hold the blade so it's more nearly perpendicular to the wall, to avoid humped joints.

Now let's run through a few typical procedures. Usually, the first job you'll do on fresh drywall is taping the flats with self-sticking fiberglass mesh. This tape is superior to paper because it is thinner and doesn't require an embedding layer of mud. When taping boards that were cut to size, be sure to pound in (with the knife handle) any ragged edges that may have been left. It's crucial that the tape lie absolutely flat.

Now, using either thumb pressure and pulling up or finger pressure and pulling down (but not both), apply a layer of mud over the tape with your 10-inch knife. Then, on a second pass, scrape off the excess, leaving just enough mud to fill the holes in the mesh but with the tape visible.

On angles, conventional creased paper tape must still be used. Using a six-inch knife, first run a thin undercoat of mud along both sides of the corner. Then cut pieces of tape to length, fold them on the crease, and press them into place. Or you can use a banjo taping machine to perform all operations at once.

After taping, you're ready for spotting—filling the small nail or screw holes created when the wall was hung. The basic motion is to apply cement and wipe it clean with a single swirling motion. A pressure exchange occurs between the thumb and forefinger. If you hold the knife with your elbow turned in, then the pressure begins with the forefinger and ends with the thumb. If you begin with the elbow turned out, then the thumb pressure comes first. As you work—generally from bottom to top and from left to right (it's right to left for lefties)—look out for mud sagging in the holes. If the mixture is even slightly too thin, you must remove the mud twice from the hole, or you'll end up with hardened domes all over your walls.

Finishing for smooth walls

Once your first coat of mud is complete and fully set, the next thing to do is scrape. Anywhere the compound is not perfectly smooth—at tape edges or where the knife has left chatter or stop marks—you simply scrape lightly; the finish becomes smooth as glass. No sanding is necessary. Tape that has beaded up can be simply sliced off; its mesh network is unaffected by the loss of a piece here and there.

Now comes the finish coat. Covering the tape line on angles is easy when working with soft hot mud. Coat both sides with a six-inch knife, then scrape off, working up from the bottom and down from the top.

Finishing butt joints requires great care to avoid leaving a noticeable hump. If the butt does not meet properly, it may have to be feathered out over a distance of two feet or more. After the first coat and a good scraping, slide the edge of a broad knife along the joint to locate the more severely sloped and hollow side. Fill this side slightly with your 10-inch knife. Later you'll come back for third and fourth treatments. For these, use a 14-inch knife and spread the joint out over a 28-to-30-inch width, being careful not to build up over the joint itself.

When all joints, nails, plumbing runs, and electrical boxes (see photos) have been fully smoothed out, there is one more step before you're ready to coat the wall (unnecessary if you plan to use a textured finish). Using a 14-inch knife, apply a skin coat of mud to the entire wall surface, then remove it. This leaves a frost over everything that highlights any slight imperfections that would show up when the wall is painted.

The blemishes that appear are touched up using a technique called the one-shot coat-and-clean. It's a special movement pros use to work at great speed with a minimum of return strokes to the mud pan. Although you may not need to perform with the same efficiency pros do, it may still be useful to know the proper method. The key to the technique is getting a shot of mud properly centered on the blade edge. This is done by loading the knife in the usual way, then cutting off one corner and shaking the rest down to the center. The one-shot uses the natural spring of the blade to cover a blemish and scrape the tool clean all in one motion. With finger pressure applied, push down on the blade and make it bend back, then as you pull away, elevate the handle until the blade springs back. I've seen skilled journeymen do touch-ups with this technique for several minutes without once hitting knife to pan and without leaving any chaff behind.

When the touch-up is complete, remove the skin coat. This is the only time I ever sand, using 150 paper to lightly brush down the entire surface (the backless-type sandpaper pictured on the opening page is a great boon because it never clogs). Then sweep off the dust with a soft broom and the wall is ready to be primed and painted. My favorite paint treatment for a smooth wall is two coats of semi-gloss latex enamel over one coat of thinned primer. PS

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Automotive trouble-shooting quiz

By STEVE MERCALDO

Questions

1. Car pulls to one side

Your car has developed a strange problem. When you go faster than five miles per hour, the steering wheel acquires a mind of its own—it pulls to the right. As you speed up, the problem gets worse. At first the pulling was slight, but lately it has become annoying.

You pick the logical place to begin trouble-shooting: the radial tires. All are properly inflated. You take a close look at the treads and find no unusual wear patterns; all treads are equal in depth and no cupping is evident. You know that the wheel balance is good because each wheel was balanced recently. And the steering wheel doesn't shimmy at any speed.

You check the front and rear hydraulic brakes (a dragging brake could cause a pull). You jack and support the car on a hard, level surface. After applying and then releasing the brake pedal, you attempt to spin each wheel by hand. All spin freely.

With the car down on level ground again, you check to see if the curb height is good. It is—and side-to-side and front-to-back, the car sits level.

You decide you've done all you can. As a last resort you visit two old friends, Frank and Lou, who work at a front-end specialty shop. They do a routine check of the front-end parts and find that, except for minor wear, everything looks all right: MacPherson-strut assemblies, lower ball joints, lower control arms and bushings, and radius arms and bushings all pass their critical inspection.

The rack-and-pinion steering assembly (which is not power-assisted) is in good shape and properly adjusted. The tie-rod ends also look good.

They put your car on the alignment rack and get these readings:

	Caster (deg.)	Camber (deg.)	Toe-in (in.)
Left wheel:	1+	1½	0.05
Right wheel:	1+	1⅜	0.05
Specs:	1⅚+	1½+	0.08–0.12

After this, each mechanic comes to a different conclusion. Frank says the pull is caused by a defective front radial tire. Lou says the pull is caused by the caster angle not being correct on both wheels. Who is right?

2. Engine overheats

Ever since you serviced the cooling system of your engine, it's been plagued by overheating. When you maintain engine speed above idle, the dash temperature needle climbs into the "hot" zone, pressure builds up, and steam starts escaping into the recovery tank. When you bring the engine down to idle speed, the temperature goes back to normal.

You begin by reviewing: When you serviced the cooling system, you pressure-tested it for external leaks. The system held pressure for several minutes—no leaks were evident.

Then you flushed out the system with a heavy-duty two-part chemical flush and replaced the upper and lower radiator hoses, heater hoses, thermostat, fan belt, and radiator cap.

You felt a sense of pride as you gave the engine a final once-over. That feeling lasted until you drove the car.

Now you try to find the problem by performing a step that you skipped during the routine service: You flush the radiator fins, thinking that perhaps they're clogged with road dirt, leaves, or bugs. With the engine turned off you spray a garden hose at the fins from the engine side of the radiator. Some dirt comes out, but not enough to convince you that it's causing a problem.

Perhaps the new thermostat is defective. Or maybe you installed it backward. You drain coolant into a clean pan and remove the thermostat. No luck—it was installed correctly, with the temperature spring facing the engine. But rather than take the time to test the thermostat, you put in a new one.

Could the chemical flush have loosened dirt in the system? The dirt may be blocking the cores of the radiator, restricting the normal flow of coolant. To find out, you bring the engine to operating temperature and throttle it to approximately 2,000 rpm. You touch the front of the radiator and find that the entire fin area feels relatively cool, yet you can hear the beginnings of the familiar sounds of the engine starting to overheat. Then you notice something unusual: The lower radiator hose looks as though it's collapsed.

Why is your car overheating?

3. Engine has the shakes

Your car's four-cylinder engine idles so roughly it's unbelievable. It's so bad, in fact, that you jokingly attribute your recent loss of a few pounds to the shaking you get when you're

Continued

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stopped for a traffic light. Yet when the engine runs above idle speed, its performance is normal. At cruising and high speeds, you have no problems.

Your search for a remedy begins with a tuneup. As you remove each spark plug, you inspect for unusual deposits or wear. Nothing—all the plugs show signs of wear, but none is fouled.

You then do a compression test. The readings for each cylinder are well within the specification of 160 psi.

You put in new spark plugs, properly gapped. With an ohmmeter, you check plug wires for external cracks, breaks, and proper resistance. The meter reading for each wire is approximately 12,000 ohms. The specifications call for a maximum resistance of 25,000 ohms. You inspect the distributor cap, rotor, and coil tower for cracks and corrosion. All parts look good.

When you take off the distributor cap to give the electronic-ignition parts a close inspection, you see that the pickup coil and reluctor are fine. There are no signs of metal-to-metal contact between them and the pickup-coil wires. The other primary wires are not broken or frayed. An ohmmeter reading of the pickup-coil indicator shows it's good.

Next you service the positive-crankcase-ventilation (PCV) system, changing the PCV valve, hose, and engine-breather filter.

You tighten the carburetor screws and mounting fasteners, along with the intake-manifold bolts, and change the fuel filter and air-cleaner filter element.

When you check the vacuum hoses, two are questionable (loose on the fittings). You replace them.

You adjust ignition timing to the setting indicated on the engine-compartment tuneup decal and finish by adjusting the curb idle to the recommended specification. The mixture screw is plugged off with a cap, so you leave it alone.

Nothing you've done has improved the idle, so you proceed to even more detailed testing. You attach a vacuum gauge to a source of manifold vacuum. At idle the gauge needle floats between 16 and 18 inches of vacuum. As you increase engine rpm, the needle steadies at 20 inches of vacuum. These readings are within the normal range for your car.

Undaunted, you direct your attention to the PCV system. Perhaps, you think, the vacuum source for the PCV valve is clogged with carbon and causing the rough idle. Because you just replaced all the serviceable parts, you know they're good—but without vacuum the system can't operate. To check, you plug the PCV valve with your finger as the engine idles. The rpm drops slightly, then returns to speed when you release your finger.

Maybe the exhaust-gas-recirculation (EGR) valve is defective? You carefully remove the valve and inspect the gasket for damage; it looks fine and seems to be closing properly. There's very little carbon accumulation. Just to be sure, you hold the valve upside down and drop a little soapy water around the valve and seat. The liquid remains puddled there—it doesn't drain into the valve chambers.

With the EGR valve back in place and the engine idling, you search for a vacuum leak. You spray carburetor-choke cleaner carefully around the intake-manifold gasket, carburetor-mounting gasket, and all the vacuum hoses. The idle does not smooth out. But you do notice that when you spray cleaner into the carburetor air horn, the idle speed increases and the engine runs smoothly.

Maybe a vacuum-operated device, such as the power-brake unit, is leaking vacuum internally. To find out, you disconnect the power-brake unit's vacuum hose at the intake manifold and plug the manifold fitting. The idle remains rough. You perform this test on all the other vacuum-controlled devices that use the intake manifold for a source of vacuum. The problem persists.

What's causing the rough idle?

4. Engine stalls

Your car's engine has become as unpredictable as the weather. It cuts out when you're driving on the highway and can't be restarted. But if you let the engine cool down for about 15 minutes, it starts and performs normally. Then, maybe a week or so later, it acts up again.

Thinking that a tuneup might solve the problem, you install a new set of spark plugs, plug wires, ignition rotor, PCV valve, distributor cap, and all fuel and emissions filters.

As part of the tuneup, you check the fuel-delivery system. The specifications call for a pressure of three to five psi and a volume of one pint in 30 seconds. You get 3½ psi and 1¼ pints in 30 seconds. The fuel you collect looks clean—there is no water or dirt in the bottom of the container.

You skip testing the battery, cranking circuit, and charging circuit because just a week ago you took the car to a local shop for a new battery, and the mechanic tested each circuit for you.

After adjusting the timing and carburetor to factory specifications, you take the car for a road test. It performs well and doesn't cut out.

Three days later, much to your consternation, the engine stalls while you're driving to the next town.

You pull off the road to a safe spot and remove the air-cleaner assembly, checking for fuel by looking into the carburetor air horn as you move the throttle linkage. A liberal amount of fuel spurts out of the accelerator-discharge nozzles.

To check for spark, you remove a spark-plug wire and hold it about ¼ inch from the engine block. No spark jumps from the wire when the engine cranks. Now you know you're on the right track: It has to be an ignition problem. Several minutes later you repeat the spark test and get a healthy shot of electricity across the gap from wire to engine block.

You manage to get home and consult your repair manual. The engine is equipped with a General Motors high-energy ignition (GM HEI). You make a quick visual inspection. No wires appear to be broken, frayed, or rubbing against a metal part.

Next you turn on the ignition key and test the input voltage to the BAT terminal of the distributor. It registers 11 volts on a voltmeter. When you check the pickup-coil wires with an ohmmeter, you find a resistance of 600 ohms. Pickup-coil resistance should be between 500 and 1,500 ohms. The pickup-coil wires are not frayed, and the terminals are clean and fit snugly on the module.

An ohmmeter check of the ignition coil indicates the following: Primary resistance is 0.5 (specification is zero to one ohm); secondary resistance is 12,000 ohms (specification is 6,000 to 30,000 ohms).

Realizing that an ignition coil can sometimes break down under load, you take the coil to a local repair shop and have it load-tested on an analyzer. Under load the coil delivers 40,000 volts.

Puzzled, you reinstall the coil. You're sure that the problem is igni-

[Continued on page 130]

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PS leisure-home plan

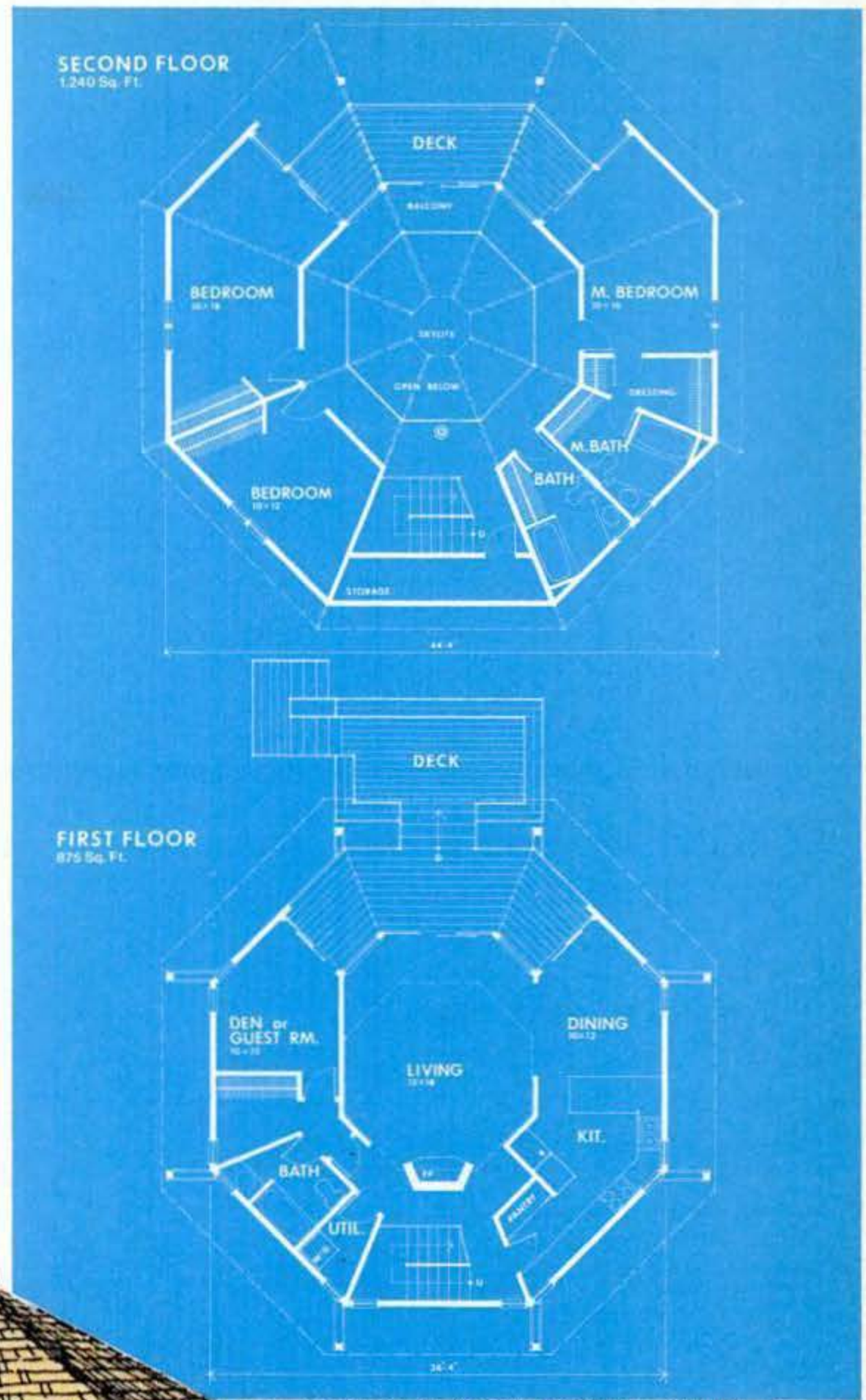
Hurricane haven

By AL LEES

Many ocean-front lots are subject to high-tide flooding, so zoning for such sites is increasingly strict, often requiring floors of any living areas to be at least eight to 10 feet above normal high tide.

This octagonal hut could be erected anywhere (it adapts well to a steep hillside), with part of the ground level used as a carport or boat shelter—or enclosed as lockable storage (the plans detail two types of foundation). But, built on open pilings as shown, the house meets most hurricane codes, since it's firmly rooted and would ride above high water. The double-pitch roof lifts the center portion to support a skylight at the peak. Dotted lines on the upper floor plan show the rafter pattern.

The top floor features a balcony ring that looks down into the center-core living area. Wrapped around this are the bedrooms and back-to-back baths. Two of the bedrooms (and the ring) have direct access to an upper deck, aimed toward your prize vista. Both floors are reached from ground level by an enclosed stair (not visible). PS



How to order your plans

Construction drawings for the Hurricane Haven (VPS #59) are $65 a set, $95 for three sets, $20 for each extra set. Add $3 for postage in the continental U.S., $5 elsewhere. Catalog of V-PAC plans is $5. Send check (U.S. funds) to Vacation Plans Service, Box 622, Princeton, N.J. 08540. MasterCard or Visa orders: call (609) 924-9655.

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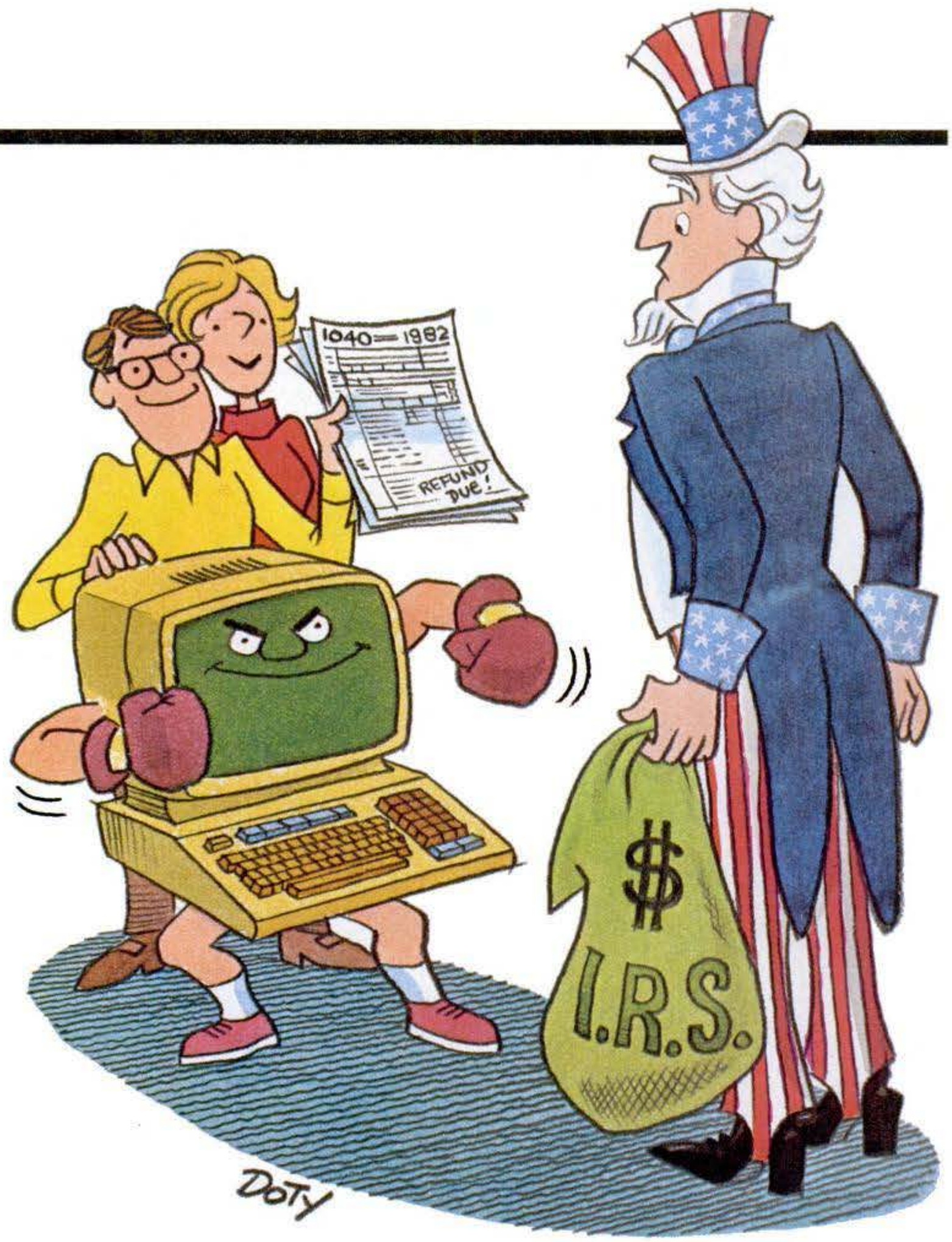
Popular Science ELECTRONICS

Computer programs do your income taxes the easy way

Will income-averaging help? Should you itemize? Ask your computer

By GORDON MC COMB
ILLUSTRATION BY ROY DOTY



What a test! Last year I completed my income-tax return in the usual way: using paper, pencil, and a calculator. Now I was going to do it again. But this time, as a comparison, my home computer would do the work. Would it be faster? More important, would it save me money?

I told the computer I wanted to analyze three alternatives: On the first one, I asked it to recalculate my 1981 return using the same information. On the second, I asked to see how income-averaging would help me. And on the third alternative, I wanted to see how well I'd do if I income-averaged *and* itemized my deductions.

The results were incredible. According to my computer, had I income-averaged, I could have saved $225 last year. (The itemized deductions didn't help.) The program nearly paid for itself on its first test. And the results, which would have taken me hours, were printed out in minutes.

For some, tax time has meant hours of paperwork drudgery. For others, it's meant finding—and paying for—professional help. But now, for those who own a personal computer, it can mean just popping in a program and following instructions.

This year, a variety of income-tax programs is available to teach your computer the basics: how to accept your income data, how to choose the correct numbers from their built-in tax tables, and even how to fill out the appropriate tax form. All work on the taxes for Uncle Sam, but some include the tables you'll need to prepare your state income tax, too.

No, these programs probably won't replace a good tax accountant, but in many cases they can save you time and money. As I found out, there are a number of types of income-tax programs—each with strong and weak points in certain areas. Choosing the right one for your needs is your most important step. Here's what I learned:

Preparation and planning

There are two general types of income-tax programs: the *preparer* and the *planner*. The tax preparer digests your tax information, per-

Continued

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10"x 10" panel

FRESH AIR BREAKTHROUGH!

ZESTRON, THE LEADER IN ION TECHNOLOGY, ANNOUNCES SUPER-ION OUTPUT IN A BIPOLAR ELECTROSTATIC PRECIPITATOR. "THE COLLECTOR" COMBINES SPACE AGE TECHNOLOGY WITH TRUE VALUE AND PERFORMANCE TO IONIZE AND CLEAN YOUR INDOOR AIR OF HARMFUL, POLLUTANTS BETTER THAN ANY OTHER IONIZER.

THE COLLECTOR

IF YOU WANT CLEAN FRESH AIR OR YOU'VE UNPLUGGED YOUR POPULAR FILTER-FAN UNIT BECAUSE IT DOESN'T WORK, THEN READ ON.

Is your indoor air fresh, clean and alive? Indoor air pollution is becoming a national health hazard. Energy efficient airtight buildings are stifled with stale polluted air which includes smoke, dust, pollen, viruses, and bacteria. Most of these pollutants are so small (under 5 micros) that they are not effectively removed by common small filter-fan units. Scientific tests show that these noisy inefficent units which emit chemical "citrus" odors are more like toys, and are no match for high-powered ionizers in thoroughly cleaning the air we breathe.

ANOTHER IMPORTANT DIFFERENCE

You know how good and vibrant the air feels right after a rain storm with that crisp, fresh smell? Just like in the mountains, near a waterfall or at the ocean. That clean, alive fresh air is rich in something important that is missing or greatly depleted in our urban and indoor air. The missing element is negative ions, nature's own air cleaners. *Scientists claim that these amazing active ions are of great benefit to you and can actually make you feel alive, revitalized and alert while relieving depression, headaches and allergies. Negative ions promote sound sleep, learning and healing and even make plants grow better. In addition, hospitals use ionizers in burn units to destroy bacteria and reduce pain.*

Filter fan units do not emit negative ions. The COLLECTOR, by Zestron, creates trillions of these beneficial ions every second, while giving you the best performance, value and technology in air cleaning.

THE ZESTRON BREAKTHROUGH!

Most ionizers clean your air but leave an untidy deposit of pollutants on room and furniture surfaces near the ionizer. The COLLECTOR by Zestron takes ion technology a giant step forward by giving you superpowered ion output while depositing pollutants from your air on the collector panel. This easy to clean panel features a scientifically formulated surface that electrostatically attracts the vast majority of airborn pollutants to it rather than to the floor or walls near the ionizer.

ADJUSTABLE OUTPUT-DETACHABLE COLLECTOR

Some people prefer fewer ions at night. The COLLECTOR is the only adjustable bipolar ionizer that allows you to set the ion level to your personal preference. The detachable COLLECTOR allows you to place it where you want to protect desired surfaces and facilitate cleaning. The scientifically formulated surface instantly wipes clean unlike other bipolar ionizers whose porous surfaces absorb odors and unsightly grime.

AMAZING DEMONSTRATION!

Unplug your COLLECTOR and place a facial tissue on top of the collector panel, then place the ionizer unit and an ash tray on top of the tissue. Place a lit cigarette in the ash tray and watch the smoke rise into the air. Now plug it in, and amaze yourself and friends as the smoke barely rises above the ashtray and then nose-dives into and is absorbed by the tissue before it can enter the room air. This air cleaning is accomplished entirely electronically with no moving parts! The COLLECTOR by Zestron is the only ionizer on the market that cleans the air powerfully enough to accomplish this test.

SUPERPOWER OUTPUT

The COLLECTOR by Zestron is the only bipolar collecting ionizer with superpower output. The thoroughness and speed of air cleaning increases with more ion output, and Zestron ionizers give you the highest output (without detectable ozone). Check the comparison chart below. Don't buy any ionizer not stating output using the industry standard of ions/cc/ sec. at one meter.

IONIZER	ADVERTISED OUTPUT (1 m.) ions/cc/sec.	COLLECTOR
The COLLECTOR By Zestron	1,200,000	YES
JSA Bubble	???	YES
Aspen	???	YES
Orbit	???	YES
AirCarell	236,000	YES
Ion Fountain	540,000	NO
Ion Cloud	350,000	NO
Ionosphere	350,000	NO
Modulian	75,000	NO
Ion Breeze	???	NO

FREE ION DETECTOR

A FREE remote ion detector comes with each ZESTRON to verify and compare output. When you place the detector next to a ZESTRON and a competitive unit, you will see greatly reduced or no output from the competitive unit!

SILICON VALLEY TECHNOLOGY

The COLLECTOR, incorporating years of high reliability design experience, is built in the heart of Silicon Valley, USA, using quality parts operating under low stress. It is designed to give you space age performance and years of trouble free service. The COLLECTOR operates anywhere in your home or office on regular current for pennies a month. It has no moving parts and nothing to wear out or replace.

THOUSANDS OF SATISFIED USERS

Don't you, your family and friends, deserve the healthy clean fresh air that Zestron ionizers have brought to thousands of satisfied users? Users write:

"I simply cannot believe how much better I feel physically" Dr. E.K., DDS - MA

"I smoke heavily and it has cleared the air as advertised" G.P. - WA

"I haven't taken the top off my nasel decongestant spray since using your product. I was previously a chronic user." G.S. - SD.

When you use your COLLECTOR, you'll quickly feel the difference it makes and smell the freshness in your air. You'll actually see the elimination of smoke and dust in your air!

SATISFACTION GUARANTEED

Order a COLLECTOR now and try it in your home or office risk free for 30 days. You will probably want more units, but if for any reason you are not satisfied, return the unit for a prompt and courteous full refund including your return postage. The COLLECTOR has a full one-year warranty on both parts and labor, excluding abuse.

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Reorders are pouring in, customers write:

"We are enjoying the results of the first one and are ordering two more" Dr. J.B., M.D.-CA

"Very pleased with the first unit . . . send two more" Dr. D.M., D.C. - CA

"I'm a distributor for three other ion companies, and have to say I am extremely, extremely impressed." T.N. - CA.

ZESTRON, the leader in ion technoloy, has created a unique DEALERSHIP PROGRAM. Call or write for details on this RISK FREE OPPORTUNITY.

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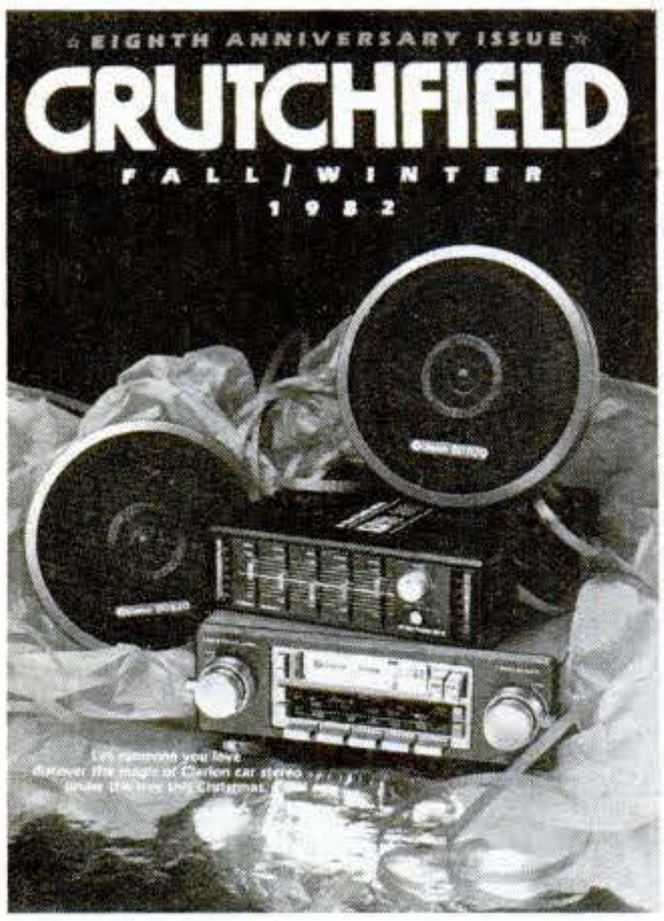

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PAGE 1

BOB AND MARY JONES
PROJECTIONS

	PROJECTION 1982	PROJECTION 1983	PROJECTION 1984	PROJECTION 1985
FILING STATUS	JOINT	JOINT	JOINT	JOINT
NUMBER OF EXEMPTIONS	3	3	3	3
WAGES, SALARIES	54,500	62,675	72,077	82,889
INTEREST AFTER EXCLUSION	550	700	0	0
DIVIDENDS AFTER EXCLUSION	0	0	0	0
CAPITAL GAIN/LOSS	0	0	0	0
PARTNERSHIP INCOME/LOSS	0	0	0	0
OTHER INCOME/LOSS	0	0	0	0
TOTAL INCOME	55,050	63,375	72,077	82,889
ADJUSTMENTS TO INCOME	0	0	0	0
ADJUSTED GROSS INCOME	55,050	63,375	72,077	82,889
DEDUCTIONS				
MEDICAL & DENTAL EXPENSES	0	0	0	0
STATE & LOCAL INC TAXES	0	0	0	0
OTHER TAXES	0	0	0	0
INTEREST EXPENSE	0	0	0	0
CHARITABLE CONTRIBUTIONS	0	0	0	0
CASUALTY LOSS	0	0	0	0
MISCELLANEOUS	0	0	0	0
TOTAL DEDUCTIONS	0	0	0	0
ZERO BRACKET AMOUNT	3,400	3,400	3,400	3,400
EXCESS ITEM. DEDUCTIONS	0	0	0	0
SUBTOTAL	55,050	63,375	72,077	82,889
EXEMPTIONS	3,000	3,000	3,000	3,000
TAXABLE INCOME	52,050	60,375	69,077	79,889
TAX - TAX TABLES/XYZ	14,207	16,179	18,980	23,521
TAX - QUAL. CAP. GAINS	** N/A	** N/A	** N/A	** N/A
TAX - INCOME AVERAGING	13,897	15,977	18,617	23,524
TAX - MAXIMUM TAX	** N/A	** N/A	** N/A	** N/A
TAX SELECTED	13,897	15,977	18,617	23,521
ADDITIONAL TAXES	0	0	0	0
GROSS REGULAR TAX	13,897	15,977	18,617	23,521
CREDITS	0	0	0	0
NET REGULAR TAX	13,897	15,977	18,617	23,521
MINIMUM TAX	0	0	0	0
ALTERNATIVE MINIMUM TAX	0	0	0	0
OTHER TAXES	0	0	0	0
TOTAL TAX LIABILITY	13,897	15,977	18,617	23,521
FEDERAL PAYMENTS	0	0	0	0
BALANCE DUE (REFUND)	13,897	15,977	18,617	23,521
TAX BRACKET	39	40	38	42

Tax projections, such as this one from Aardvark's PTP program, give you a glimpse into the future. Purpose: Make changes now to save money later.

forms all the arithmetic, and displays each applicable tax form and schedule—including that most important bottom line.

Many tax-preparation programs, such as Tax Preparer from Howard-Soft and Professional Income Tax from McBride Accounting, will show a mini-version of the tax form or schedule on the computer screen. It will print the result directly onto a standard 1040 form or, when appropriate, create a facsimile—the computer prints out both your individual tax information and all lines and text from the schedule. You simply send the completed printout to the IRS.

But as Bill Gabbert, owner of Datacell, a software firm specializing in tax programs for the professional, told me, "You must be careful when submitting computer-assisted returns to the IRS. They will not accept computer-generated facsimiles of the 1040 form, so a good tax-preparation program will print out the data directly onto a readily available 1040. The other schedules can be in facsimile form, but they must fit certain specifications."

Be certain that the tax-preparation program you buy provides you with IRS-approved printouts of each form and schedule. If the program or program literature doesn't tell you this specifically, *ask*. Otherwise your tax return may be rejected by the IRS.

The second type of tax program, the planner, doesn't actually print out a finished form or schedule. It creates a report that tells you the most profitable approach (for you, that is) to take when filing your tax return. As an example, Professional Tax Planner by Aardvark Software can give you two types of planning aids: alternatives, which allows you to see the effects of various tax strategies; and projections, which lets you see what your taxes might be like up to five years

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No wonder the TS1000 is the fastest selling personal computer ever. And Sinclair will let you try it in your home for 10 days at no risk.

Buy three cassettes, get one free. A good reason to order now.

The fact that computers are here to stay is probably reason enough to order now.

However, we also feature a special software offering. When you buy three cassettes, you get a free cassette. It's as simple as that. And now you can buy the computer and both 1K programs and 16K programs right from your home. No crowds, no waiting lines, no parking worries. Selecting from such a large variety of software has never been easier or more convenient.

But you have to order right away, this is a limited time offer.

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Call our toll free number and use your MasterCard or VISA. Or send the coupon with a check or money order.

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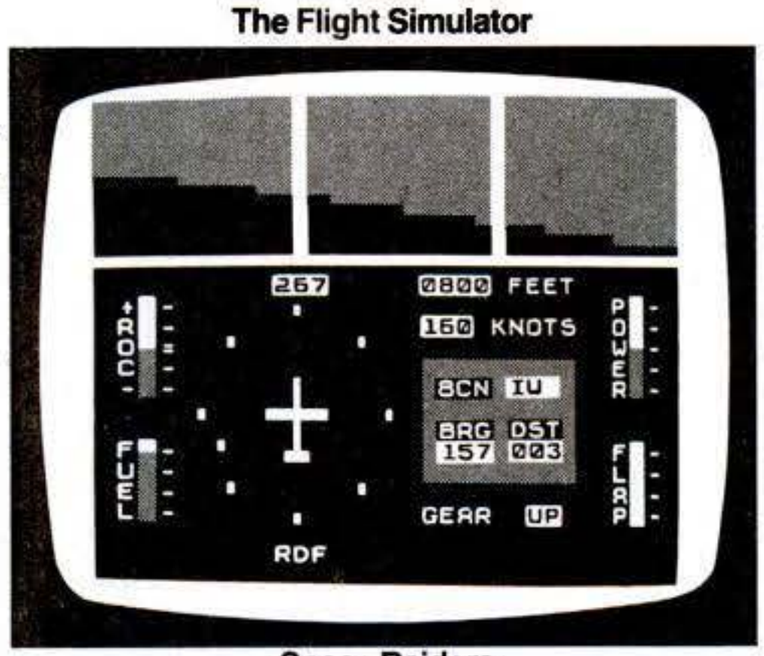
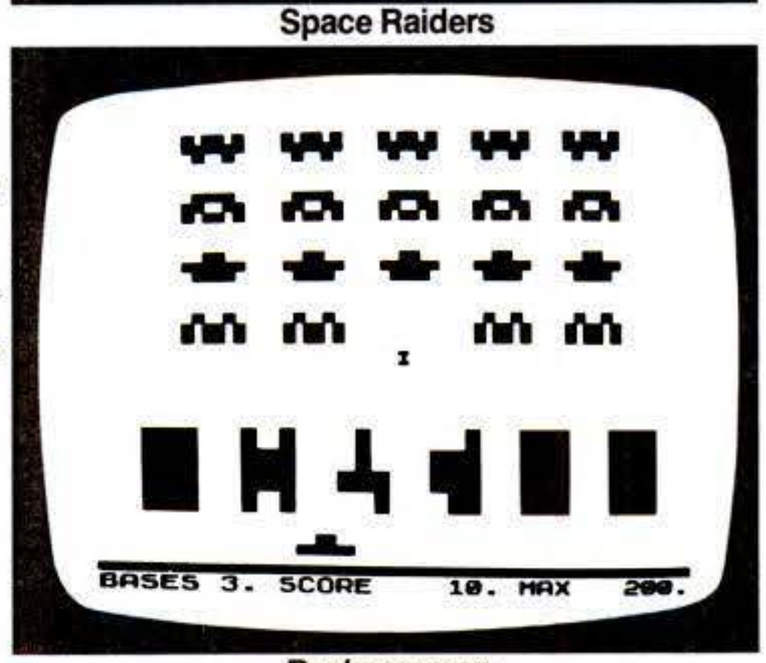
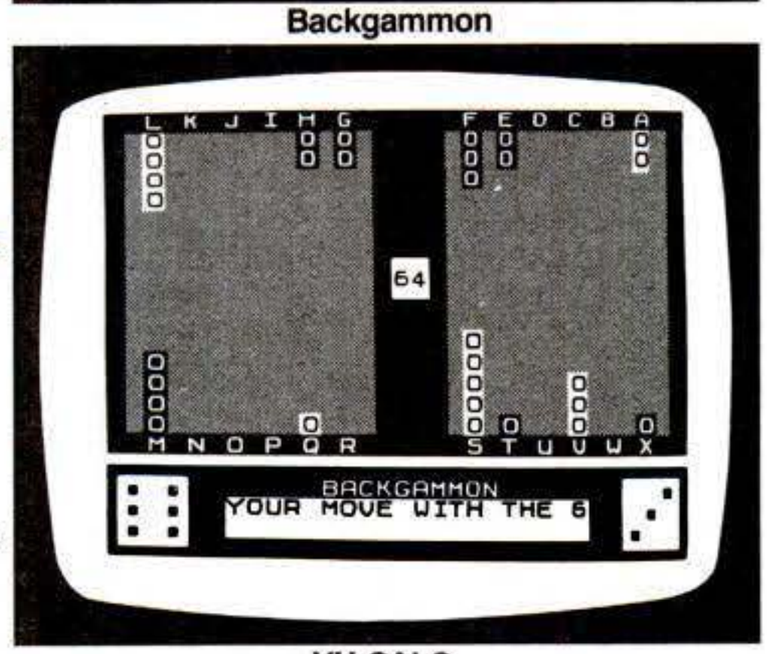
The Flight Simulator



Space Raiders



Backgammon



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	Price	Qty.	Amount*
TS1000 Computer	$99.95		
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1K Cassettes	$ 9.00		
16K Cassettes	$15.00		
Shipping/ Handling	$ 4.95		$4.95
*U.S. Dollars		Total:	

1K Cassettes for basic computer: $9.00 each

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5.	Snackman (Better than Packman)	$19.95	$15.95
6.	Bug Blast (Creepy)	$19.95	$16.95
7.	Anti Matter Splatter (Nuclear Disaster)	$24.95	$19.95
8.	Bombs Away (Great)	$18.95	$15.95
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from now (a bit depressing but educational). Tax planners display their results on the computer screen and provide you with printed reports.

A few programs are a combination of the two, such as Datamost's Tax Beater and HowardSoft's Tax Preparer. Such programs, however, perform one function better than they do the other. For instance, Tax Preparer can produce a finished 1040 and schedule A only. But it will not print either form; you must transfer the displayed data onto the proper form by hand.

That means there is a trade-off when you choose a tax program. If you're more interested in experimenting with different alternatives to find your minimum tax liability, a tax planner may be the perfect choice. But if you already have a good idea what your tax approach will be and simply want to make it easier on yourself by computerizing your tax return, choose a preparer.

Using a tax preparer

I tried many of the tax-preparation programs now available. They all produce about the same result—a 1040 and some schedules. For example, Tax Preparer is easily loaded into the computer by inserting the program disc and turning the computer on. The program loads automatically and greets you with a list of five major options. You press a single key to begin filling out your return.

You can't breeze through all the forms and schedules without stopping or sidetracking, however—because the IRS doesn't let you do that. Information from almost all of the schedules eventually winds up on the 1040, so you need to fill out the form a step at a time and complete each required schedule when you come to its line entry. While this slows down the process considerably, Tax Preparer automatically performs all the necessary mathematical calculations and transfers the entries from one schedule or form to the other.

After you have completed all of the schedules, you return to the 1040. Tax Preparer now automatically locates your tax liability from any one of the tax tables you specify (the tables are built-in so you don't need to do any cross-referencing). You can experiment and pit your adjusted taxable income against any or all tax tables to find your lowest tax liability.

After you've entered all the required information, you can then

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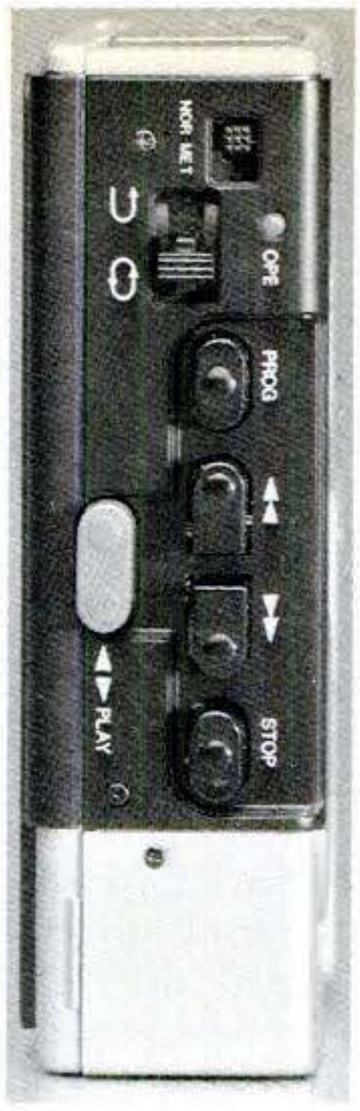

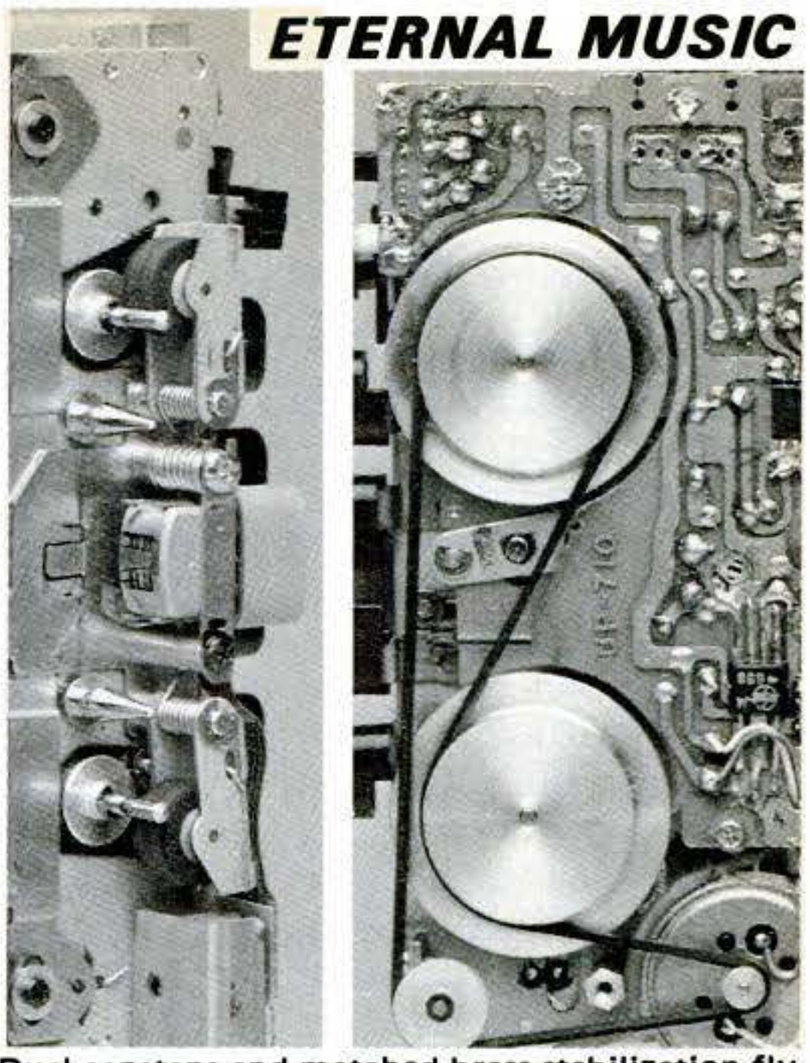

Dual capstans and matched brass stabilization flywheels give you rock stable bi-directional play.

Musical Chain Reactor

Just touch the Bi-Directional play button once and you'll experience a nonstop musical chain reaction. You can listen to this personal stereo while you're on the move or with the included interface, sit back and enjoy an evening of nonstop, uninterrupted music through your own home stereo. Even a regenerating power supply is included free.

Kick back and relax. Here's a personal stereo with thundering kaleidoscopic sound that you'll wear when you're out, but that you'll probably get even more use out of at home.

Later you'll read about the sophisticated electronics, the dual capstans and the anti-rolling tape movement system with twin matched brass flywheels (pictured above). But, first let's see what this deck has to offer that's so special for use at home.

NOT A $1000 DECK

No, the new DAK Micro XV5000 continuous play auto-reverse deck won't outperform the specs of your $1000 home cassette deck. But, it's closer than you'd imagine. And when you use the special interface cable we supply as a FREE BONUS with the deck, you can plug the deck directly into any 'aux' or 'line' inputs in your stereo system.

Now here's the good part! The sophisticated Bi-Directional play mechanism of the deck provides you with continuous unattended play of both sides of your cassette over and over again.

You can be in bed and have hours of uninterrupted music. At the office, you can listen to your cassettes without worrying about changing them when they get to the end.

So while you may prefer your current expensive cassette deck for its specs, you'll love this deck for the freedom it gives you from changing or turning over cassettes every 45 minutes or so.

And this deck is no lowlife. It plays both normal and metal tapes. The fidelity is so good that if you want to copy a tape, just play it on this deck and record a new copy on your current home deck.

ON THE ROAD

Slip this ultra microsized champagne gold personal stereo into its matched protective leatherette case complete with belt loop and shoulder strap.

Then plug in the 1½ oz. Samarium Cobalt headphones and you're ready to hit the road. At 11 oz. and at only 4½" X 3½" X 1½", it's less than 1/4" wider than the cassette box it's pictured sitting on above. (Cassette not included).

Whether you're into gymnastics, long walks, or mowing the lawn, you'll enjoy the unbelievably rich stereo sound.

The deck incorporates a special dual flywheel tape movement system with a unique anti-rolling mechanism resembling a fine clock. It compensates for movement to keep the music smooth and stable even when you're not.

Wait till you see this incredible deck glide into action. As each of the dual capstans (pictured above) effortlessly and automatically engages you can see and feel the mechanical quality just as sure as you will hear the sophisticated electronic quality by the clear dramatic musical sound this deck produces.

You can easily test the stability of a personal stereo cassette deck by shaking it while you listen to music. If the music wows badly, or even stops, you have a cheap unit. DAK's is superbly stable. We feel it is easily equal or superior to anything we've seen on the market.

FREE BONUS ENERGY DYNAMO

What you don't usually read about in most ads is that as good sounding as personal stereos may be, they tend to eat batteries. So, every 3–8 hours or so you will be laying down more of your hard earned cash to keep the music rolling.

Well No More. Here's a slightly ridiculous example. Let's say that you listen to cassettes for 4½ hours a day, 7 days a week, 365 days a year for 3 years.

With the FREE BONUS dynamo charger and the FREE BONUS energy cells included with your DAK XV5000 Micro Bi-Directional cassette deck you'll still be at full power in 3 years because the energy cells we supply carry a separate 1000 charge or 5 year limited warranty.

And best of all, in 3 years, you'll be several hundred dollars richer in money that you haven't spent on regular 'throw away' batteries. There's also a DC input that you can use to plug in any external 3V DC power supply (not included).

GUARANTEED

The XV5000 is made specially for DAK by one of the largest manufacturers of personal electronics. It's the latest generation in microsize and features. And, wait till you hear the sound.

DAK is America's largest direct selling manufacturer of magnetic products. We have been in business over 11 years. Your deck is backed by the standard limited manufacturer's warranty.

TRY BI–DIRECTIONAL PLAY RISK FREE

Take the DAK XV5000 on walks, to the mountains or as you commute to work. Then just plug it into any home or office stereo system for continuous **nonstop** play of your favorite cassettes.

If for any reason you aren't 100% satisfied, simply return it and our special free bonuses in their original boxes within 30 days for a courteous refund.

To order your DAK XV5000 Bi-Directional Personal Stereo Cassette Deck complete with the home stereo interface the dynamo charger and energy cells risk free with your credit card, call the toll free hotline, or send your check for the incredibly low introductory price of **$79** plus $3.50 for postage and handling Order No. 9600. CA res add 6% tax.

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review the form or schedule line by line. The calculations have already been made.

If you print out your tax forms, be sure to use the 1040 form specified by the program. (Some forms are available from sources other than the IRS and may not be compatible with your program, causing improper alignment of each printed entry.)

Finally, most publishers of tax-preparation programs offer state-tax returns, as well. Often, you don't have to fill out both the federal and state returns separately. Tax Preparer, for example, automatically transfers the information you've sweated over from the federal return to its proper place on the state return.

Using income-tax planners

Income-tax planners allow you to enter your gross income along with specific deductions and other tax-related information. You then can compare different strategies to find your best tax. Just as with tax preparers, most planners are easy to use.

Aardvark's Professional Tax Planner (PTP), for example, lets you concurrently analyze up to five separate tax alternatives. (This is the program I—happily—used earlier.) You merely enter the data requested by PTP, then sit back as your computer literally helps pay for itself.

Most other programs like PTP will also let you look into the future and estimate your projected income and tax liability for a current year and up to four years beyond. Of course, the information you provide is only an estimate, but gazing into the crystal ball of a tax-planning program will let you know if you need to take steps to help decrease your tax liability for the coming years.

The information supplied by a tax-planning program can either be viewed directly off the computer screen or printed out in report form. PTP, for one, prints reports in a handy multi-column format so you can easily compare the results of each alternative or projection.

Both the tax-preparation and tax-planning programs are updated yearly to reflect new tax laws and revised tax tables. Unlike some software updates that are free, tax-software updates usually cost $35 to $50 each year.

Although no tax-preparation or -planning program now available will work with any other software (such as a spread-sheet program), a few of the programs, such as Tax Preparer, can use information you've entered into last year's program for the new tax season.

But, of course, you can't use a program written for 1981 taxes to complete a return for 1982 income. The changes from year to year are such that not only could your return be rejected (and audited), but you could overpay more in taxes than the cost of a new or updated program.

Potential pitfalls?

While income-tax programs will help many of us, they aren't for everybody. You'll waste money, in fact, if you regularly file a 1040A (short form) return. The simple calculations required don't warrant a computer program costing $100 or more. You're a good candidate, however, if you file the standard 1040 form and one or more tax schedules, such as A, B, D, 5695, or 2119.

At the other extreme is an overly complex tax return. A computer can give you a false sense of security—a complicated form may look good when done "electronically," but if you don't know what you're doing you could easily get into trouble with Uncle Sam. (Remember, *you*—not your computer—may have to explain it.)

A good companion to any tax program is one of the income-tax-preparation guides that are commonly available at tax time. One in particular is Publication 17 (catchy title) from the IRS. From that, you can order other free income-tax guides from the government. PS

PS guide to home-computer tax programs

Publisher/ distributor	Program name	Price ($)	Update price ($)	Type	Computer	Minimum memory req.	Disc or cassette	Prints out on IRS form	Performs alternatives	Performs projections	State package avail.	Comments
HowardSoft 8008 Girard Ave. Suite 310 La Jolla CA 92037	Tax Preparer	150	About 35	Prep	Apple II	48K	D	Yes	-	-	Yes	Also does schedules A–G, SE, R/RP, 2119, 2106, 3468, 5695, 6251, 4625, 4797
McBride Accounting Box 423 Star NC 27356	Professional Income Tax	80	n.a.	Prep	TRS-80 models I, III	32K	D, C	Yes	-	-	Yes	Schedules A, B, C, D, E, F, G, SE $20 extra each
Micromatic Programming Box 158 Georgetown CT 06829	Tax Saver I	80	About 50	Prep	TRS-80 models I, III	32K	D	Yes	-	-	No	Acetate overlays also available for printout schedules A, B, G
	Tax Saver II	120	About 90	Prep	TRS-80 models I, III	32K	D	Yes	-	-	No	Acetate overlays also available for printout schedules A, B, C, D, G, SE
Aardvark Software 783 N. Water St. Milwaukee WI 53202	Professional Tax Plan	300, 350 CP/M	n.a.	Plan	Apple, IBM, TI CP/M	32K	D	-	Yes	Yes	-	Incorporates "help" screens throughout program for easy reference
Datamost 9748 Cozycroft Chatsworth CA 91311	Tax Beater	130	150	Plan	Apple II	48K	D	-	Yes	No	-	Performs limited preparation of 1040 and schedule A
Dynacomp 1427 Monroe Ave. Rochester NY 14618	Tax Optimizer	60	About 10	Plan	North-star CP/M	32K	D	-	Yes	No	-	
Micromatic (address above)	Tax Forecaster	50	n.a.	Plan	TRS-80 models I, III	32K	D	-	Yes	No	-	

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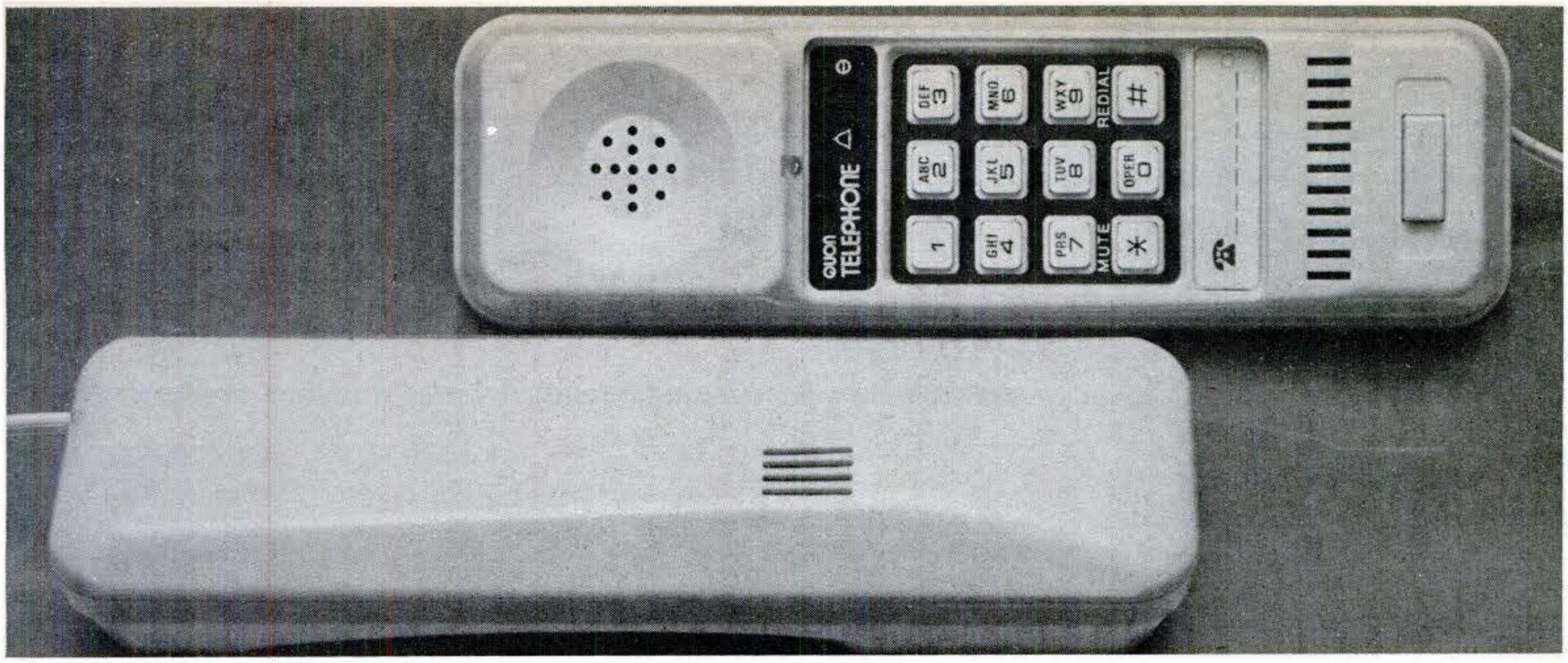


The $7 Push Button Phone

Plug in and start pushing. Now you can have highly automated phones with no monthly service charges for just $7 each. But, there's a catch.

Send back your dumb phones. Now instead of paying monthly service charges you can have push button dialing, last number redial, mute, and ringer off.

You can forget big clunky phones. You can also forget dials. This phone works perfectly whether you now have rotary or push button phones.

Now for just $7 you'll have the latest technology at a price that'll let you have a phone in every room in your home. But, don't forget there's a catch.

NOTHING TO INSTALL

Simply plug this phone into any standard modular phone jack and start talking. If you don't already have jacks, call your phone company.

They may even put them in free for you. Due to the recent Supreme Court ruling, soon they'll probably be selling you your own phones anyway. And, at worst, there's just a small one time fee.

LAST NUMBER REDIAL PLUS

It's really neat. If you call a number and it's busy this phone will automatically redial the number for you each time you touch 'redial'. There's no need to keep dialing over and over again.

When you need to speak privately to someone with you, you don't have to cover the mouth piece. Just press the mute button and the person on the line will be cut off for privacy.

When you want to take a nap, just switch the ring off and the phone won't ring. There's never a need to take your phone off the hook again.

The quality is great. A high quality condenser microphone lets the person you talk to hear you loud and clear.

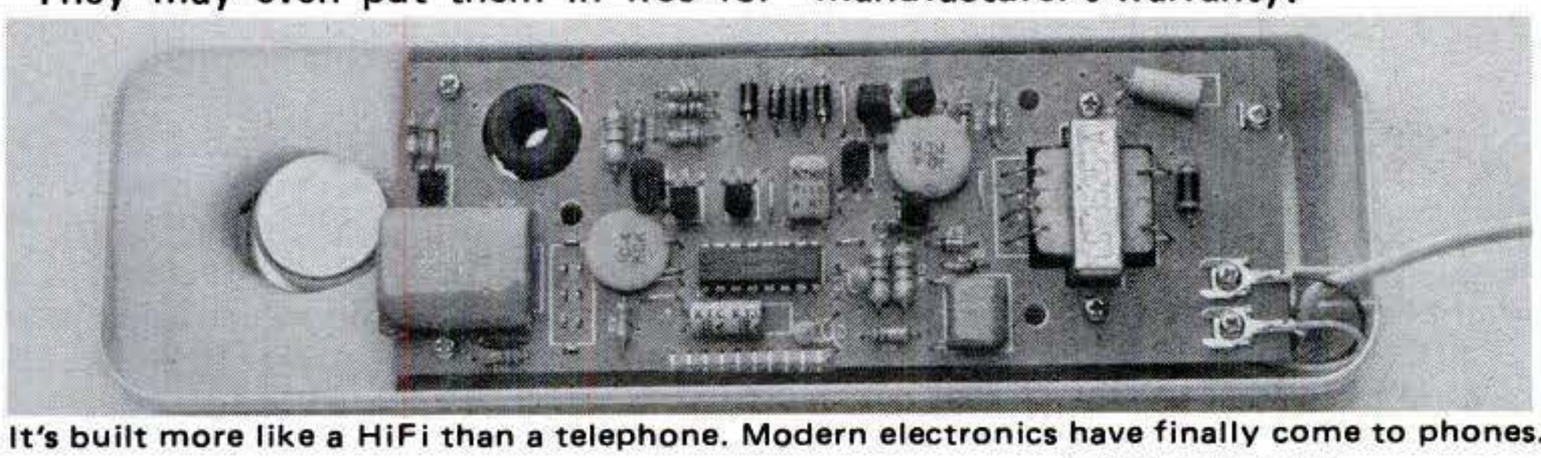
And you hear them through a high quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new.

But, the nicest part of all are the push buttons. Once you've started using buttons you'll hate dialing the old way.

With this phone you can push the buttons as fast as you want. Then the phone sends out pulses on your line that work with virtually any phone system.

So this phone works anywhere. You can unplug it and move it from room to room or house to house in seconds.

The phone automatically hangs up when you set it down or you can push its 'hang up' button. It comes complete with a 14 foot coiled cord and a limited manufacturer's warranty.



It's built more like a HiFi than a telephone. Modern electronics have finally come to phones.

THE CATCH

Frankly we are losing our shirts on the automated phone, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 150,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

To get the automated phone for just $7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the automated phone for only $7 with your credit card, call the DAK toll free hot line or send your check for only **$24.90** for the tapes, plus **$7** for the phone and **$3** for postage and handling for each group. Order No. 9416. CA res add 6%.

An automated Phone for $7 and DAK's new improved MLX. Time to stock up.

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BITS & BYTES

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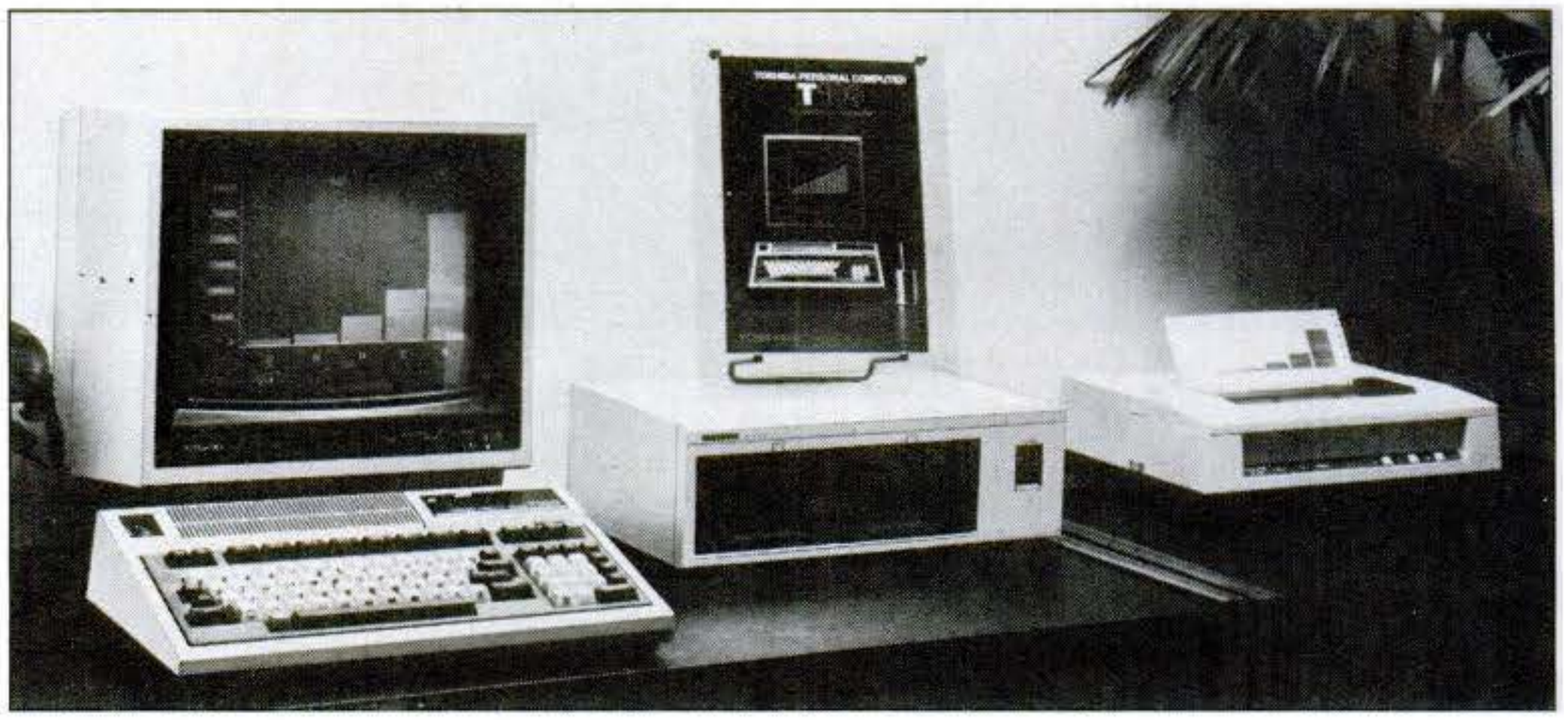

A Japanese invasion

Personal-computer entries from Japan haven't really dented sales of domestic models—so far. But there's a tidal wave of new Japanese desk-top computers on the way. I spotted Toshiba's T100 (photo) at an Info '82 exhibit held in New York City recently.

The $795 keyboard-computer section houses a Z-80A microprocessor, 32 kilobytes of ROM, 64K RAM, plus an additional 16K RAM for video graphics displays. Optional ROM and RAM packages are available. With Toshiba's $995 color monitor, the T100 delivers excellent eight-color resolution: 640 by 200 dots.

In addition to a standard $295 12-inch green-phosphor CRT, there's a new twist in displays for portability: An optional compact liquid-crystal panel presents six or eight lines of 40 characters (or 320 by 64 dots). The twin-drive 5¼-inch mini-floppy-disc system is costly: $1,295.

Toshiba, like other manufacturers (see concluding item), implies that one of its new dot-matrix printers delivers the crisp printouts of daisy-wheel printers—at twice the speed. Toshiba's $2,195 Letter-Perfect P1350 can spew out letters at 160 characters per second (cps) in its draft mode. But for "letter perfect" printing, the 24-pin print head operates at 100 cps, using a single-pass, overlapping-dot technique. High-quality graphics, with 180 by 360 dots per inch, are also possible. The nine-by-seven-matrix, 120-cps P1010 model shown costs $795.

While the T100 is aimed at small businesses, another device shown at Info '82 is more likely to appear in the offices of big conglomerates. Toshiba's OCR-V100 page reader, about the size of a 25-inch table-top TV, scans typewritten pages at 250 cps and converts printed characters into signals that can be fed into any word-processing computer. The OCR-V100 automatically swallows up to 100 pages stacked in its hopper. The idea behind the V100: Dictated material typed on existing typewriters can be revised by authors, then scanned by a V100, and fed into a word processor—without retyping.

Quick looks

- Owners of $160 (discount) Vic 20 computers and $595 (list) Commodore 64s may hesitate to buy word-processing software priced at several hundred dollars. Now there's a $65 package, adapted from a version for Ohio Scientific hardware, that works with both computers. It's full-feature software that runs with the Vic-20's 22-column width or an 80-column add-on board, says Quick Brown Fox (548 Broadway, New York, N.Y. 10012).
- Bad news for budget-minded CIA-types, banks, and businesses: So-called dual-key encoding techniques for securing computer data have been cracked by specialists—one using an Apple II computer and BASIC program. This method relies on publicly available codes or keys the sender uses to scramble data sent to the receiver, who unscrambles it with a secret decoding key. But Israeli mathematician Adi Shamir, employing advances in number theory, cracked such a code devised at Stanford University. And University of Southern California computer scientist Leonard Adleman broke another public-key encryption code with a microcomputer BASIC program. One code that Shamir helped author is still secure.
- Charge-coupled-device TV cameras that can be linked to computers for robotic and control applications in industry [PS, Jan. '82] are now available at a relatively modest price for Apple, IBM, Radio Shack, Timex Sinclair, and Commodore 64 personal computers. Micron Technology Inc.

Continued

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Don't blame your TV if it doesn't sound as good as your stereo. Now for just $7, you can get full rich vibrant TV sound through your own stereo system. But, there's a catch.

It's amazing. TV sound is really great. It is actually broadcast on the FM band.

In fact, **all** of those great sounding FM stations from FM 88 to 108Mhz that you listen to on your home stereo are actually tightly jammed between just the 2 TV channels 6 and 7.

So, why do TVs sound so crummy? Well, if you compare a $1000 stereo system to even the best $800 TV, you'll realize that when you bought your TV, all the talk was probably about picture quality, sharpness, and color purity etc.

The truth is that in most TV sets, all the money goes into creating the best picture quality, and the sound is left to a cheap PM (permanent magnet) 3" or 5" one way Low Fi speaker and an even less impressive 1 or 2 watt amplifier.

Your stereo on the other hand may have 25, 50, or even 100 watts per channel to drive 2 or 3 way speaker systems that create breathtaking sound.

Now you can have the best of both worlds. Great picture and great sound. You'll experience sound effects, music and dramatically lifelike sound that's startlingly vibrant. It's yours for just $7. But, don't forget there's a catch.

KNOCK YOUR SOCKS OFF SOUND

It doesn't matter if you have an $89 black and white portable or an $800 color TV. Your stereo system's sound is bound to be much better than the TV's.

DAK's new Sound Enhancer TV to Stereo Interface lets you use your TV just like any other audio component (it plugs in just like your turntable) to plug into your preamp or receiver.

Actually there's no installation. Just locate the earphone jack on your TV. Then plug in the special cable (included) between your TV and the Enhancer.

Connect the standard stereo cables (also included) from the Enhancer to any 'aux' or 'line' input into your stereo system. Note: We supply 4' cables, but you can use any standard patch cords to extend the distance.

Then sit back and prepare for a shock. You'll harness all the dramatic power of your stereo system as you watch TV.

SIMULATED STEREO

Well, the sound is terrific. And yes, it does come from both speakers. But, real stereo it's not. If you're looking for trumpets from the right and drums from the left, forget it.

What you will get is a separation of the channels, and a feeling that the sound is different from each speaker. It simply sounds great.

The TV Sound Enhancer Stereo Simulator works by taking the standard 8 ohm earphone or speaker output from your TV, transforming, enhancing and altering it into two high impedance 'simulated stereo' outputs to plug into your stereo. It works with all stereos and all TVs with earphone jacks.

In addition to enhancing, there's an output volume control and high filter.

Once you've plugged into your stereo, you can make audio cassette recordings with your own cassette deck just as you would from any other sound source. The quality is great. And, it's backed by a standard one year limited warranty.

THE CATCH

Frankly we are losing our shirts on the TV sound Enhancer, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 210,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices; and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

TRY NEW DAK MLX90 CASSETTES RISK FREE

To get the Enhancer for just $7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the Enhancer in its original box within 30 days for a refund.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the TV Sound Enhancer for only $7 with your credit card, call the toll free hot line or send your check for only **$24.90** for the tapes, plus **$7** for the Enhancer and **$3** for postage & handling for each group. Order No. 9610. CA res add 6%.

Vibrant TV sound for $7 and DAK's new improved MLX. Time to stock up.

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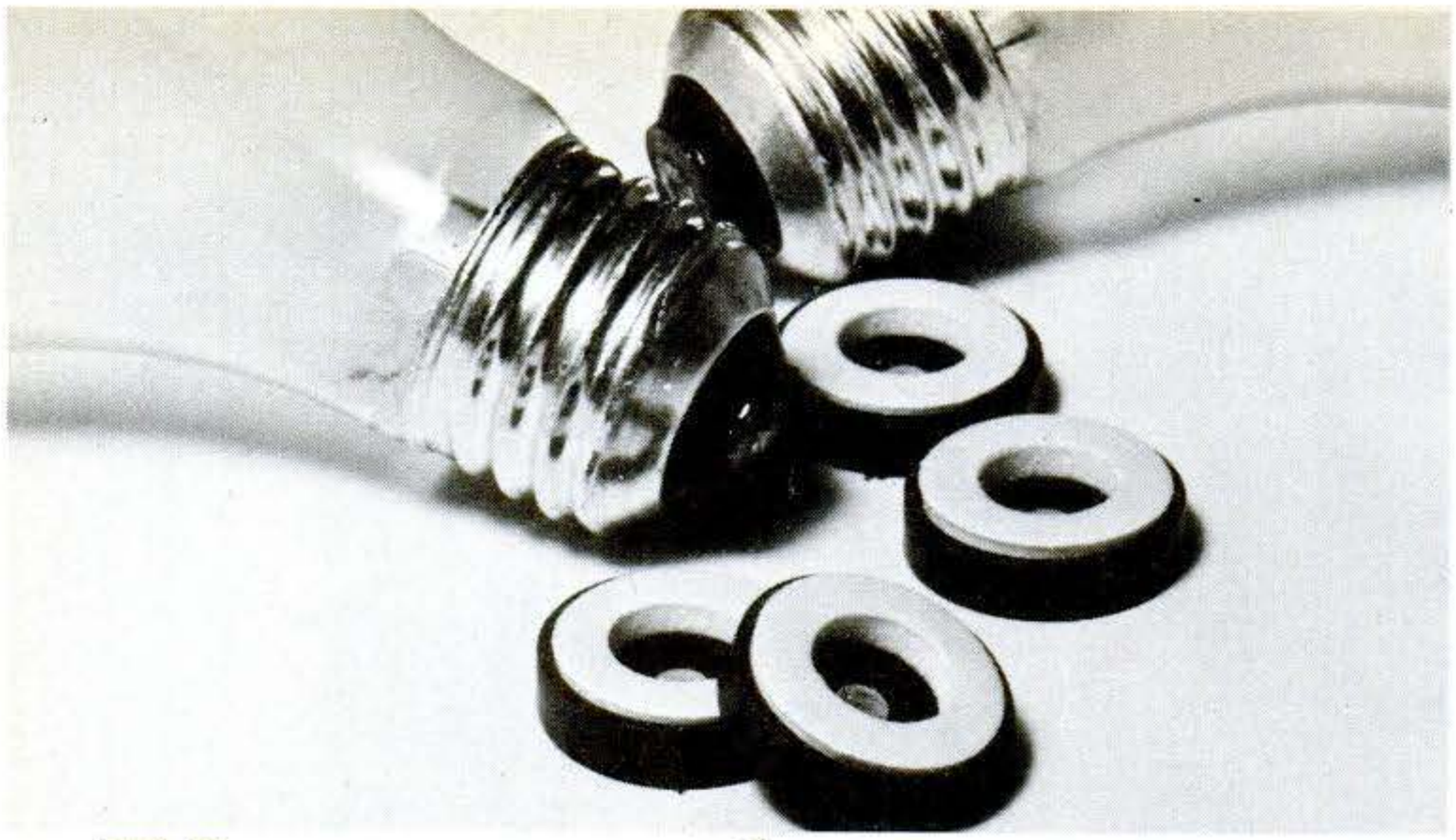

Never change a light bulb again!

The Button®...new electronic device smaller than a bottle cap extends bulb life 100 times...saves up to 30% on electricity.

Just think, no need to buy bulbs, or climb on wobbly chairs or ladders. Now, a new scientific development extends bulb life and saves electricity, too. It's called **The Button.**

The Button is a solid-state micro chip diode. It converts AC current to DC current and extends the life of a bulb filament up to 100 times!

For example, a regular bulb rated for 750 hours would last for about 32 days if burned continuously. But, with The Button, that same bulb's life would be extended to 75,000 hours or 8 years! In typical part-time home service, you may never have to replace it!

BURNING SINCE 1925

A real life example of the advantages of DC lighting may be seen any day at Thomas Edison's Florida home. The original bulbs have been burning since 1925 and are still going strong!

USE IT ANYPLACE

This amazing development works with any regular incandescent light bulb up to 400 watts, (except 3-way bulbs) including small-base candelabra bulbs.

Just stick a Button to the bottom of a bulb and screw into socket. The results are amazing. Bulbs burn cooler, and give a softer less glaring light. You save up to 30% on electricity and just think of the money saved on light bulbs!

PROVEN IN COMMERCIAL USE

The Button is absolutely ideal for lights that run 24 hours a day like exit signs and security lights. (Don't replace them until 1990!) Major hotels, restaurants and corporations are already using The Button and saving considerably on maintenance costs.

The Button has no moving parts so there is nothing to wear out. All materials meet or exceed U.L. standards and each Button carries a 10-year warranty.

GUARANTEED TO WORK

If you're sold on the idea of saving money, order The Button now. It comes in packages of 12 for **$29.95** (plus $2.45 shipping and handling). If you're still a bit of a skeptic or don't have a dozen lights, order a package of 6 for only **$15.95** (plus $1.50 shipping and handling). Either way, you're covered by the manufacturer's 10 year warranty plus Baystar's own guarantee of satisfaction or your money back within 30 days. **Specify regular or candelabra size.**

HERE'S HOW TO ORDER

To order, simply send your check or money order to The Baystar Company at our address below. Credit card holders can speed their delivery by using our toll-free number. (Md. res. add 5% tax).

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Save on bulbs, electricity and labor. Order The Button today. It's an idea that's right on the button!

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Bits & bytes

[*Continued*]

(2805 E. Columbia Rd., Boise, Idaho 83706) is marketing a $485 camera, the MicronEye. The sensor chip has 128-by-256-pixel resolution, and the interface board and disc-based software store, freeze, and compare TV frames.

- Trying to learn BASIC on an IBM PC or Apple II machine? A new $150 training package for these models, covering the disc-operating systems and three levels of IBM BASIC, has been introduced by CMA Micro Computer (55722 Sante Fe Trail, Yucca Valley, Calif. 92284). Another training course for Apple II computers, "The New Step by Step," coordinates an instructor's voice on cassettes with disc lessons on the screen and the 50-page manual. It's $70 from Program Design Inc. (11 Idar Court, Greenwich, Conn. 06830).
- Incoming freshmen at a number of colleges will be required to buy personal computers (see "PS/What's News"). Students at Clarkson College in Potsdam, N.Y., will pay $200 per semester for Zenith Z100 desk-top computers. The Z100, with both eight- and 16-bit microprocessors, costs about $3,400. At the Stevens Institute of Technology in Hoboken, N.J., incoming students must buy a $700 Atari 800 computer.
- Apple II computers received a major sales boost from an electronic spreadsheet program called VisiCalc written for Apples. IBM's PC, already climbing steeply in sales, may receive a similar boost from a new $495 combination program called 1-2-3- from Lotus Development Corp. (Cambridge, Mass.). The package, initially for the PC model only, features a simple text editor, data-base-management routines, an advanced VisiCalc-like spread sheet, and graph plotting.

Ethernet plug-in

Plug Etherlink, a $950 controller-transceiver card (photo below), into IBM personal computers, string coaxial cable,

and you've got a local-area network that enables office computers to share peripherals and data. 3COM Corp. (Mountain View, Calif.) has adopted Xerox's Ethernet network system ["Electronic Mail," PS, Sept. '80]—originally for bigger computers—to IBM's desk-top personal model and eventually other desk-tops.

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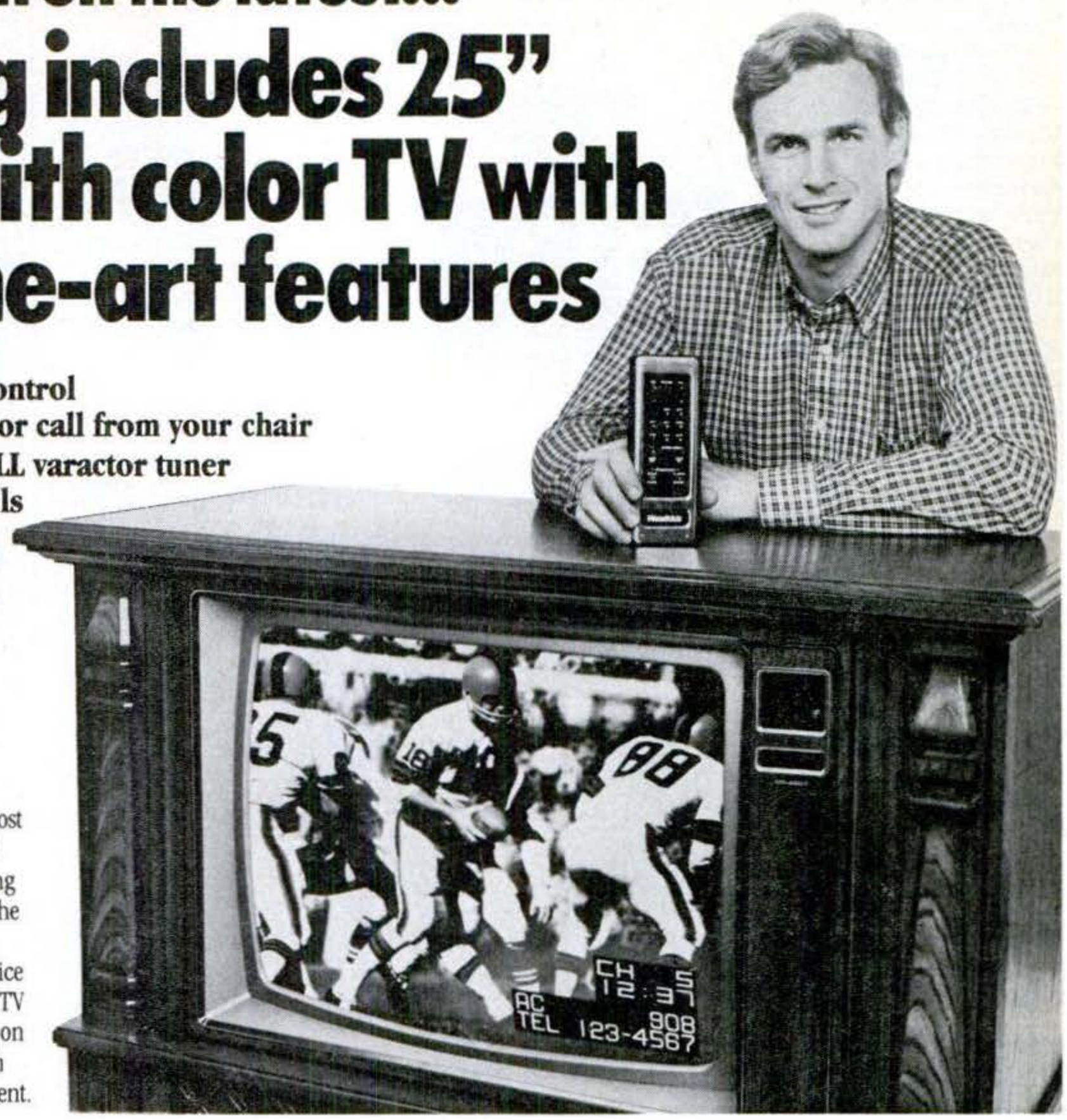
Now! Learn on the latest...

NRI training includes 25" Heath/Zenith color TV with state-of-the-art features



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We've taken the finest, most advanced, most complete TV/Audio/Video course available and made it even better. Now NRI brings your training up to and even beyond today's technology with the exciting, advanced performance Heath/Zenith Model 2501 TV. Now you can learn how to service even the latest circuitry on the most expensive TV sets as you assemble and perform experiments on your Heathkit/Zenith. Only NRI combines such complete training with such up-to-date equipment.

Choice of Three Specialties

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You can choose to build the Heath/Zenith color TV; specialize in audio systems and build your own AM/FM stereo system; or take your bench training with remote-controlled videocassette recorder featuring NRI training on videotape. No matter which specialty you elect, your practical training also includes experiments and demonstrations with the exclusive NRI Discovery Lab® and your own professional digital multimeter. All equipment is yours to use and keep.

Choice of specialty training on TV, stereo, or VCR

Learn in Your Spare Time

No need to quit your job or tie up your evenings with night school...no classroom competition or rigid schedules. NRI trains you in your own home at your convenience. You're a class of one with complete course materials, practical training on the latest equipment, and the backing of a full staff of professional electronics educators. NRI brings it all to you.

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Antache™ Biofeedback Headset lets you literally listen to the muscles that cause most tension headaches (head, neck, shoulders).

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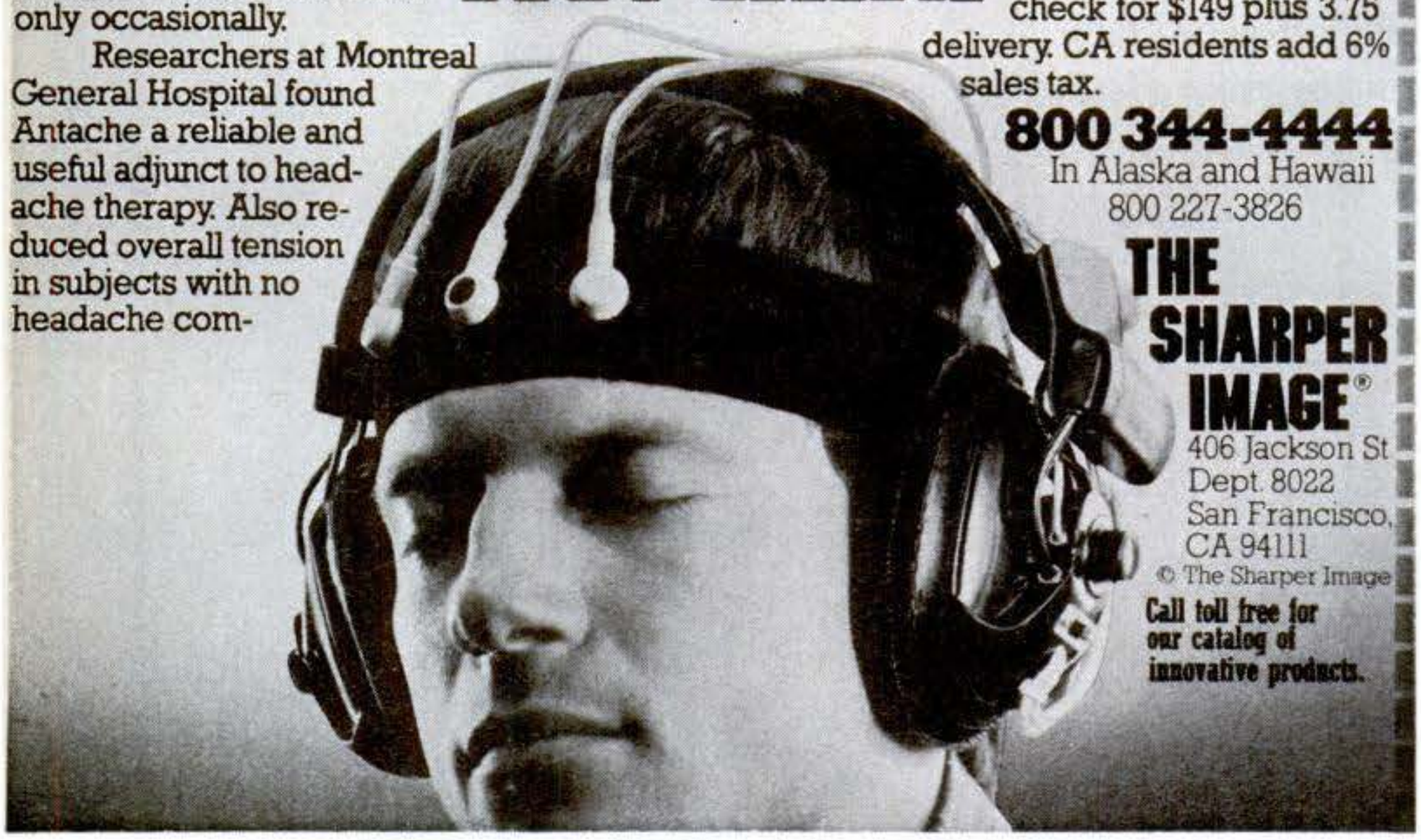

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Bits & bytes

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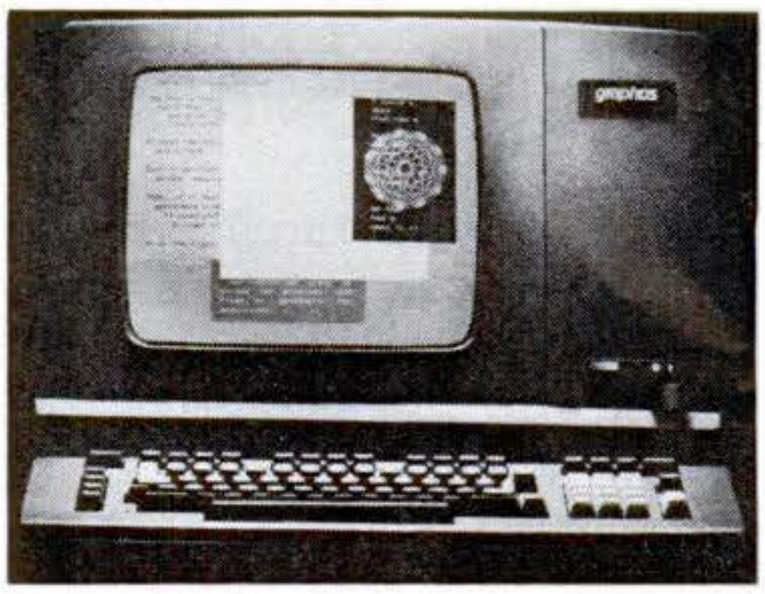
Gifted graphics terminal

One of the most powerful microprocessors on the market, Motorola's MC68000, gives Graphos, a new under-$8,000 graphics terminal, special capabilities. Up

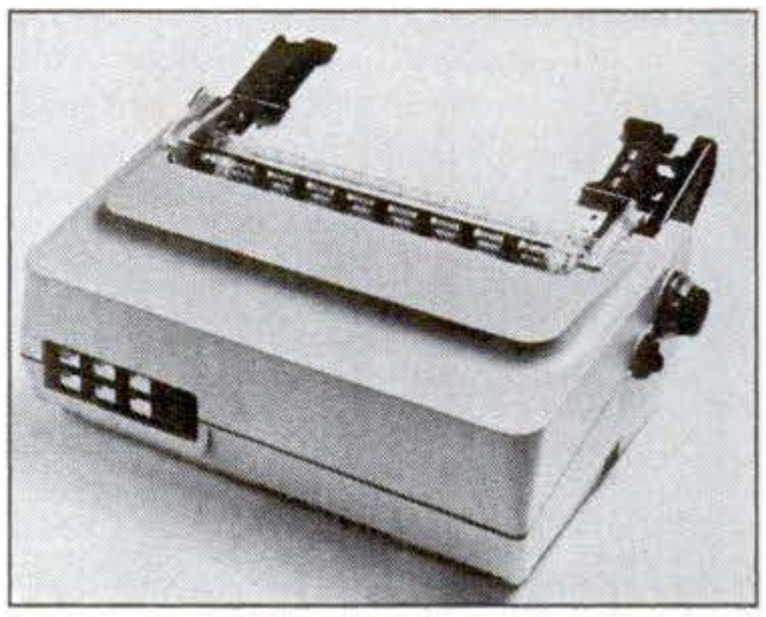


to 16 separate "windows" of different information (photo above) can be displayed simultaneously, with scroll, pan, and zoom operations possible for each. "It's like having 16 independent alphanumeric-graphics terminals available at the same time," says Ray D'Onofrio, sales manager for Ithaca Intersystems (Ithaca, N.Y.). "At under $8,000, it will actually perform more functions than $30,000 terminals," he says.

The terminal has 640-by-480-pixel resolution with 32,768 colors available (any 16 can be used in each of the 16 windows). Programs for manipulating screen data are built into Graphos, simplifying the work of computers wired to it.

Hi-resolution printer

A high-resolution mode (40-by-18 matrix) prints high-density, correspondence-quality letters at 40 cps with its new 80-



column impact printer (photo above), says Mannesmann Tally (Kent, Wash.). The data-processing mode uses a nine-by-seven-matrix character at 160 cps. For word processing, the MT160L model delivers letter-quality characters, proportional spacing, margins and centering, plus daisy-wheel codes, says the firm. Included are dot-addressable graphics features for producing bar and pie charts or high-resolution plotting. The printer has friction feed for single sheets and clip-on attachments for fan-fold paper. The MT160 has both a serial and parallel interface. Price starts at $845. PS

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New Pulse Meter makes your exercise safe & effective!

The Pulse Tach™ Heart Computer was developed for use in hospitals and doctors' offices by a select team of physicians and engineers. Read what it can do for you.

How fast does your heart beat when you exercise? How quickly does your pulse return to normal? Does this "recovery time" improve as you get into better shape?

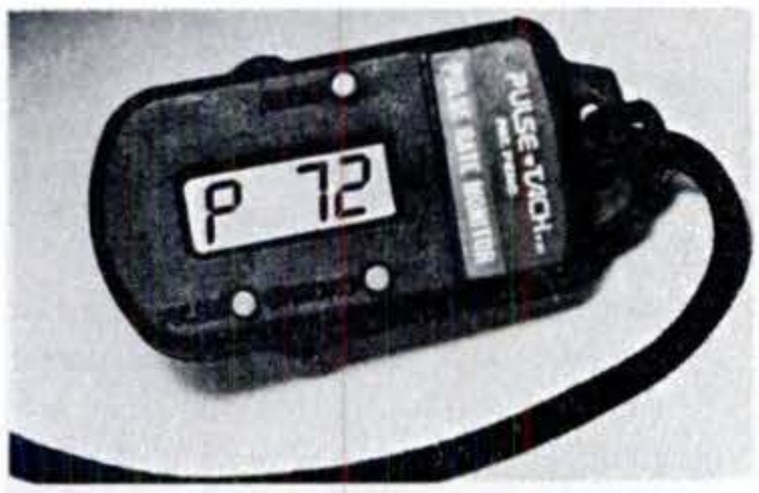
Well, guess no more. The Pulse Tach Fingertip Heart Computer accurately reports your pulse to insure maximum benefit from your exercise without dangerous over-exertion.

Pulse Tach is actually a micro-computer that fits over your finger. It weighs one ounce and can be worn easily during most exercise programs. It measures, calculates and displays what your pulse is doing.

Its custom-made, powerful micro-chip circuit replaces 5600 transisitors and makes Pulse Tach the most advanced pulse instrument ever developed for consumer use.

Reading your pulse isn't as simple as it might seem. Your heart beat constantly changes —perhaps three fast beats followed by two slow ones, one fast one, four slow ones and so forth.

Pulse Tach has **two** ways to overcome the problem. First, in general or light exercise use, it "averages" your pulse every four beats. But after heavy exercise (or if you have an irregular rhythm) Pulse Tach can also compute heart-beats over a longer span of time. In fact, Pulse Tach is accurate to .4%.



AUTOMATIC, ACCURATE HEART REPORT

After Pulse Tach evaluates and processes your heartbeat, it shows your pulse rate on an extra large Liquid Crystal Display for easy reading indoors or out.

You get the clearness and consistency of digital readout without the time and bother of manually taking a pulse.

There's more. Press a button and an audio "beeper" lets you "listen" to your heatbeat. It's like having a direct line to your heart.

ALSO A CHRONOGRAPH

Pulse Tach is more than just a way to count heartbeats. It also has an independent quartz stop watch. Now you can time your exercise period, laps or anything else up to one hour.

With Pulse Tach you know when you reach the heart rate at which exercise does the most good. The stop watch feature tells you precisely how long you're at this optimum level. Then combine both functions and compute cardiac recovery time – the most important measure of cardiovascular fitness. The better your shape, the shorter your recovery time.

Pulse Tach should be used by everyone. The fitness buff knows the value of pulse monitoring and a Pulse Tach is essential for the beginner to avoid dangerous over-exertion.

Additionally, Pulse Tach will show you how your heart is affected by coffee, a cigarette or a stressful day at the office.

It makes a great gift for a wife in aerobics or your tennis partner. In fact, anyone who exercises will appreciate this little heart computer.

THE PRICE MAY BE THE BIGGEST NEWS

Original cost of the Pulse Tach was quite high because quantities were limited to professional use. But just as pocket calculators and computers have dropped in price when made available to consumers, so, too, it is with Pulse Tach.

The Pulse Tach Fingertip Heart Computer is only **$49.95** yet its solid-state micro-chip components give better accuracy and more features than bulky, old-fashioned pulse meters costing $100-$200.

TRY IT FOR 30 DAYS

Prove to yourself that the Pulse Tach Heart Computer is the smallest, most advanced pulse monitor on the market today. Try it for 30 days. If you're not satisfied for any reason, simply return it for a complete refund — including return postage. You're protected by a 90-day manufacturer's warranty as well as Baystar's reputation for satisfied customers.

Pulse Tach Fingertip Heart Computer is just two inches long, weighs about an ounce yet it represents a major advance in personal electronics.

Your Pulse Tach will come complete with long-life watch batteries and a necklace-size lanyard to keep Pulse Tach handy when its not on your finger. You'll also receive helpful instructions including information on your "target zone," cardiac recovery time and other exercise hints.

HERE'S HOW TO ORDER

To order, simply send your check for **$49.95** plus $2.45 shipping and handling to The Baystar Company at our address below. Credit card holders can speed their delivery by using our toll-free number.

Your heart is thumping. Is it a danger signal or not? Find out. Order a Pulse Tach Heart Computer today!

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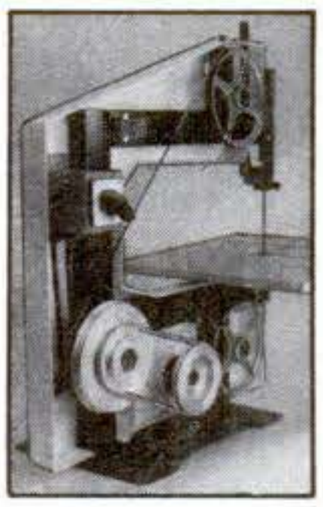

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- Three-step pulley for quick and easy change of speeds.
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Word processor
has 70-character lines with Apple II computers

Apple II computers, fresh from the factory, aren't very good for word processing. That's because the lines on a TV screen are only 40 characters long—untypical of most written material. One solution: Buy a separate character-generator board for the Apple, such as Videoterm from Videx (Corvallis, Ore.), now about $250 at discount. It will put sharp, well-formed letters (bottom photo)—24 lines of 80 characters—from a separate cable on your screen. You'll probably also want a word-processing program, which can cost $125 and up.

But how about a $130 word-processor program that can put 70-character lines on your video display without extra hardware? ScreenWriter II from On-Line Systems (36575 Mudge Ranch Rd., Coarsegold, Calif. 93614) is one of the newer packages introduced with this capability. ScreenWriter II achieves this hardware independence by using the Apple II's high-resolution graphics capability. A BASIC program creates characters as graphics elements.

I found that the shape of the letters and their small size and fuzziness (top photo) made readability poor, though. Your eyes suffer with even moderate 70-character-line use. But ScreenWriter II has a 40-character mode with normally formed Apple II characters. And the 187-page manual is packed with almost as many word-processing features as the $250 word-processing software I've been using for a year.

There are even a few new extras. ScreenWriter II has a printer spooling feature with some interface cards: You continue typing as separate material is printed. An experimental option, using the Apple game paddles to position the cursor for editing, didn't work well for me.—*John Free*

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Clear Your Home of Mice, Rats, Roaches and Other Pests — and Keep Them Out!

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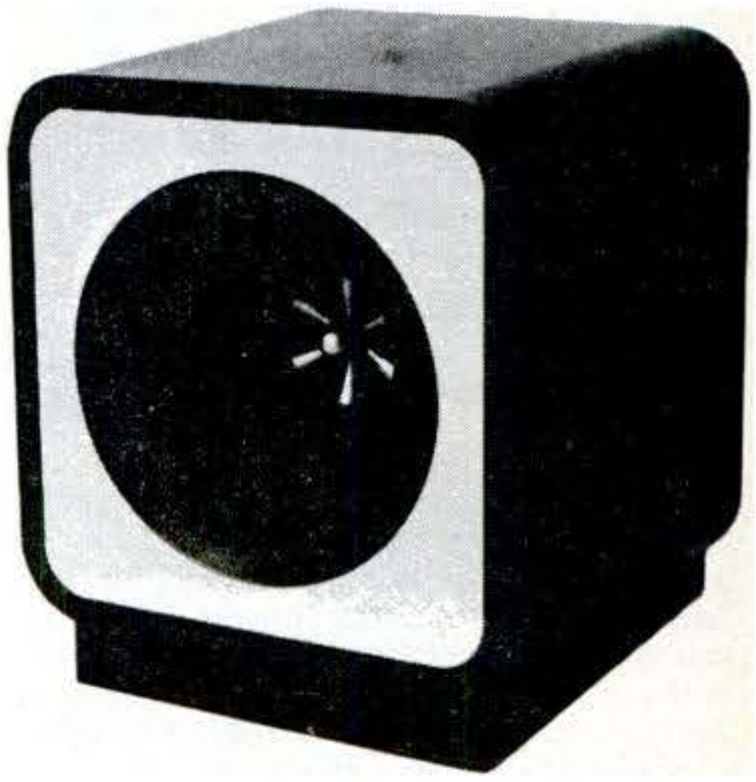

PEST-PRUFE™ is small and unobtrusive — rugged, hi-impact case has black finish with brushed silver face. Measures only 3½" x 4" x 3½". Weighs about a pound.

PEST-PRUFE™ is a home-size version of the commercial pest control device that's safe for people, pets and the ecology. Try it in your home for 30 days.

It happens every year. Cold weather drives flying, creeping, crawling pests into your home. What do you do? Fight an endless battle using dangerous traps, poisons or sprays? Or shell out good money for high-priced exterminators? Well — here's an ingenious space-age "Pied Piper" that will eliminate common household pests — and keep them out!

PESTS GET THE MESSAGE LOUD AND CLEAR!

PEST-PRUFE is a home-size version of an electronic pest control device that's used by professional exterminators. Its heart is a special quartz crystal speaker that sends out ultrasonic waves on varying frequencies (so the pests can't develop an immunity to it). You can't hear it. Neither can your pets. But mice, rats, roaches, and other pests can.

Those pests can't stand PEST-PRUFE's ultrasonic waves. It causes them extreme discomfort and pain. In fact, the ultrasonic output bothers them so much, they'll leave rather than endure it. What's more, they stay away as long as PEST-PRUFE is on the job.

JUST PLUG IT IN. AND CLEAR UP TO 2500 CUBIC FEET

You can use PEST-PRUFE anywhere there's a 110-Volt socket to plug it into. That's all you do —and those pests will disappear day by day, week by week. PEST-PRUFE uses only 5 watts — 1/10th the energy of an ordinary 50-watt bulb. And its solid state design means there's no maintenance.

PEST-PRUFE drives away:	
Mice	Rats
Roaches	Carpenter Ants
Crickets	Silver Fish
Water Bugs	Locusts
Fleas	...and many other pests

IT WON'T HARM CHILDREN, PETS, OR THE ECOLOGY

Best of all, there's no danger. A leading university tested it and found it absolutely safe for humans — even children — and pets. And it's harmless to the ecology. There's no mess — no traps to empty and reset, no dead vermin to dispose of. (They leave under their own power!) And PEST-PRUFE's ultrasonic waves will positively not have any effect on burglar alarm systems, fire or smoke detectors, garage doors, TV reception or any other electronic devices.

PEST-PRUFE is ideal pest protection. It will keep pests from inhabiting and nesting in vacation homes, campers, and boats both during the summer and off-season. Use it to control pests where food is kept or stored. Hard-to-seal areas, such as garages, toolsheds and farm outbuildings benefit most from PEST-PRUFE's ultrasonic protection.

THE PRICE MAKES IT PRACTICAL

Until recently, prices of ultra-sonic units were high — close to $200 in some cases. Only professional pest control companies used them and demand was low. But now the secret is out. Availability of lower cost components, particularly quartz crystal speakers, resulted in lower priced units. Now clean, electronic pest control is practical for everyone. PEST-PRUFE costs just $39.95 (plus $2.85 shipping and handling) but is as effective as units costing four to five times the price!

GET READY FOR THE WINTER PEST INVASION. TRY PEST-PRUFE FOR 30 DAYS AT NO RISK

Now's the time to order. Pretty soon the creepers and crawlers will be finding their way into your home to escape the cold weather. When they do — be ready for them.. with PEST-PRUFE.

Try PEST-PRUFE at home for 30 days. If you're not satisfied that its mess-free, danger-free protection isn't worth many times its modest price, your money, (including postage) will be cheerfully refunded. You are fully protected by a one-year manufacturer's warranty, as well as by Shelburne's 26-year reputation for satisfied customers.

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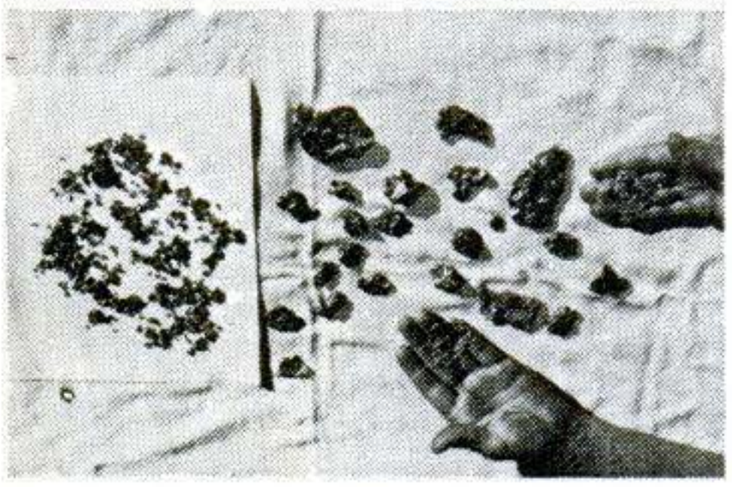
HOW TO FIND GOLD NUGGETS ELECTRONICALLY



Finding gold nuggets or coins is now made easy with a new patented gold finding detector. Before with other detectors it was virtually impossible because of interference from black sand. This new detector is unaffected by black sand and can detect pinhead size gold nuggets at great range. Its maximum range is 17 feet. It is very lightweight and has perfect balance. One of our customers who had tried five other makes and couldn't find a single nugget now reports finding up to six nuggets in one hour with his Gardiner detector. Recently a 400 ounce gold nugget was found with a detector. Free catalog.

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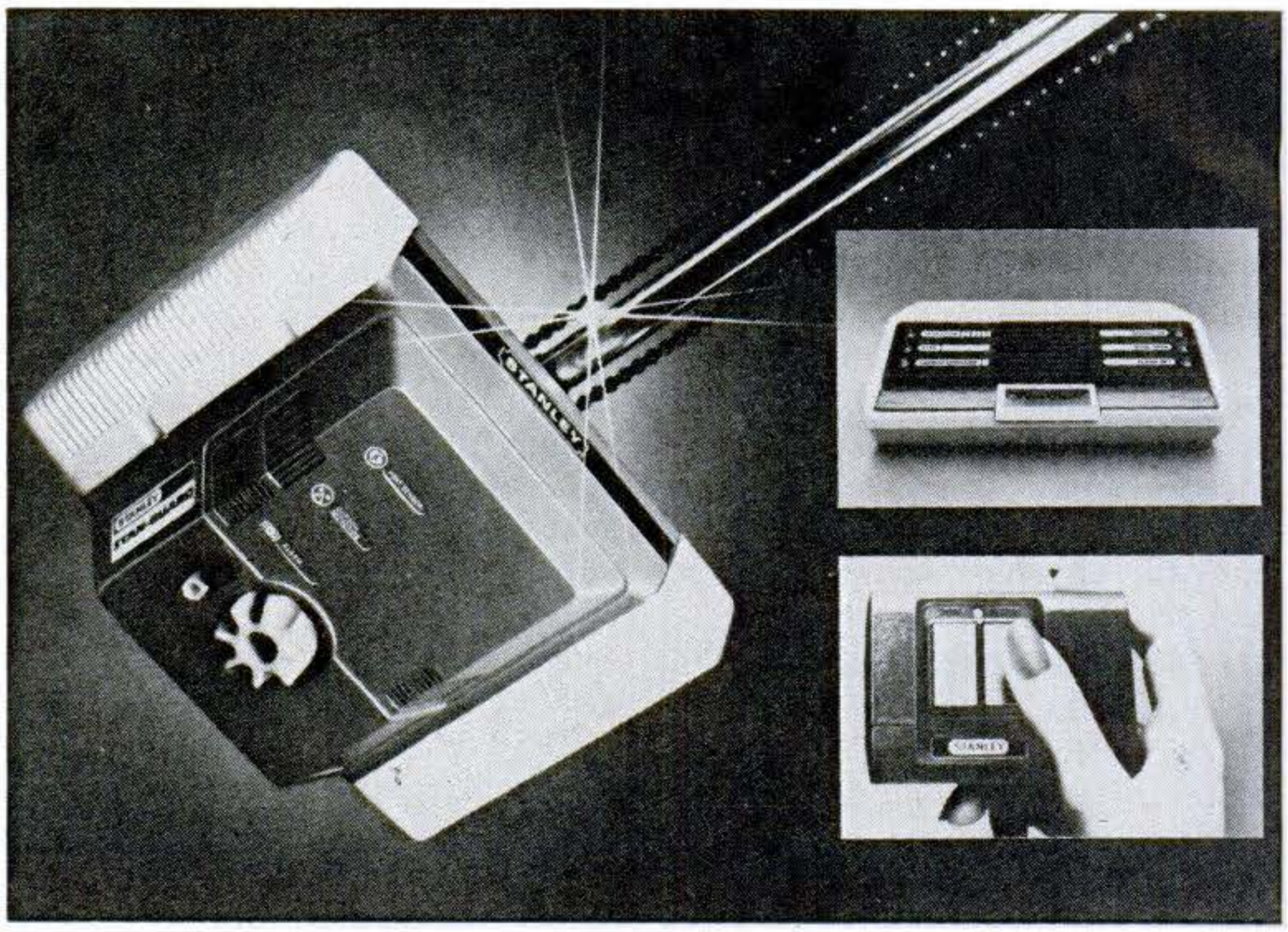

Push a button—the garage door opens. Push it again and the door closes tight. It's simple—and expected from any automatic garage-door opener. But for the unexpected, there's this Stanley Stan-Guard system: It's an automatic door opener, but it's also a burglar alarm, fire detector, and carbon monoxide warning device. And it's designed for do-it-yourself installation.

The Stan-Guard comes in three major parts: the motorized head and track assembly, an in-house monitor to remotely show you the status of the system, and, of course, a remote-control push-button unit for the car.

Installation is easy—especially since you're guided through each step by a heavily illustrated, 30-page manual. The power track comes as three metal tubes you merely insert end-to-end and tap with a hammer to secure. One end attaches to the door bulkhead, and the other slides onto the motor-drive unit. A chain drive (actually it's half chain and half steel cable) is then added to link the motor shaft to the door slide.

The Stan-Guard comes with supports to attach the motor to everything from a beam to a finished ceiling. But unlike other systems I've installed, the motor is surprisingly lightweight. It's easy to hold the drive in one hand while marking positions with the other—it doesn't have to be a two-person job.

Also, the wiring has been made simpler since the receiver and carbon monoxide monitor are built into the motor head. Rear screw terminals allow you to easily connect a manual wall button, a heat sensor, and burglar alarm detectors (all supplied).

The alarm system is controlled by a second button on the remote control. (The first, of course, opens and closes the door.) When the alarm is set, the motor is electrically locked. (I don't like that part much. In a fire, for example, that locked door could be your only quick way out.)

When the alarm is set off, an electronic warble is triggered in the motor drive. It's designed to be loud to get your attention . . . believe me, it does. At the same time, the in-house monitor sounds off and display lights show you the problem. The monitor also shows the alarm status and whether or not the door is open. All signals are received from the motor drive over the house AC wiring—you just plug it in and it works. The signals are coded so they won't interfere with a neighbor's.

The Stan-Guard is $325 and is made by Stanley, 31623 Stephenson Highway, Madison Heights, Mich. 48071. —*W. J. Hawkins*

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The Paloma® Constant-Flo Gas Water Heater is the first of its type to be design certified by the American Gas Association (A.G.A.).

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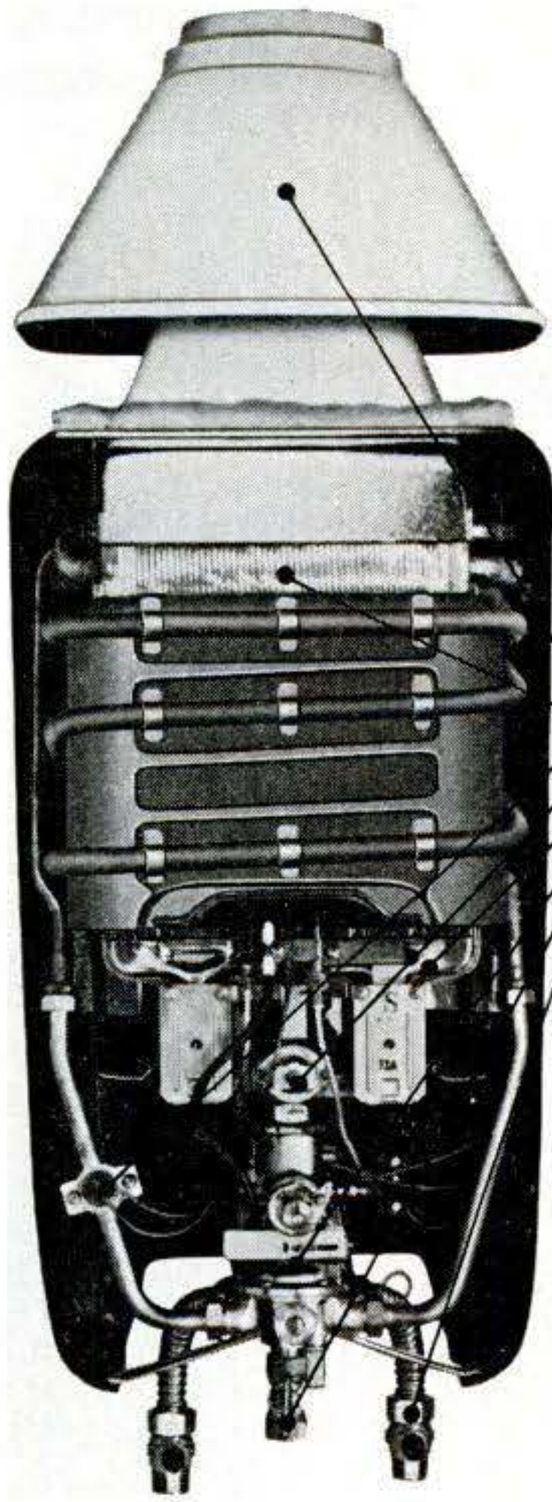

Tank System:

- Wastes precious, costly fuel keeping the tankful constantly heated.
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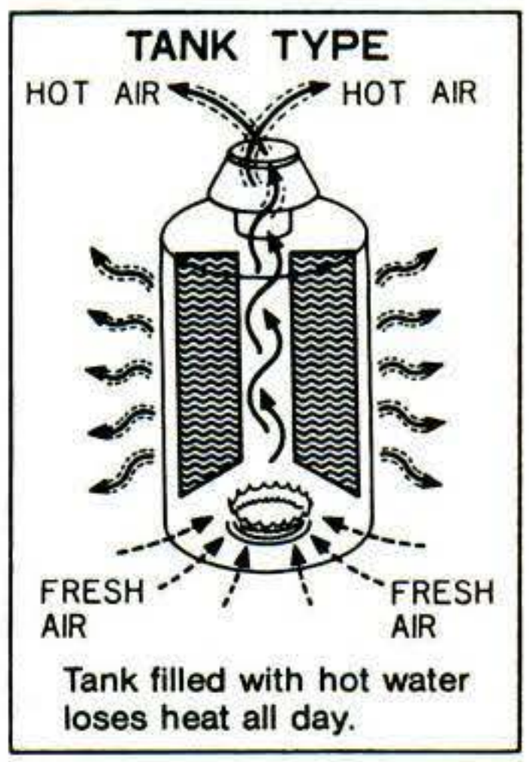

Tank filled with hot water loses heat all day.

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MODEL PH-12A-D

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MA	K-Y ENER-PRISES, INC. Lincoln Rd., RFD 4, Lincoln, MA 01773	(617) 259-8420
MI	TRECHA BROS. SUPPLY CO., INC. 5015 Holland Dr., Swartz Creek, MI 48473	(313) 635-4580
MN	ACRO ENGINEERING CO., INC. 8033 24th Ave. South, Bloomington, MN 55420	(612) 854-3147
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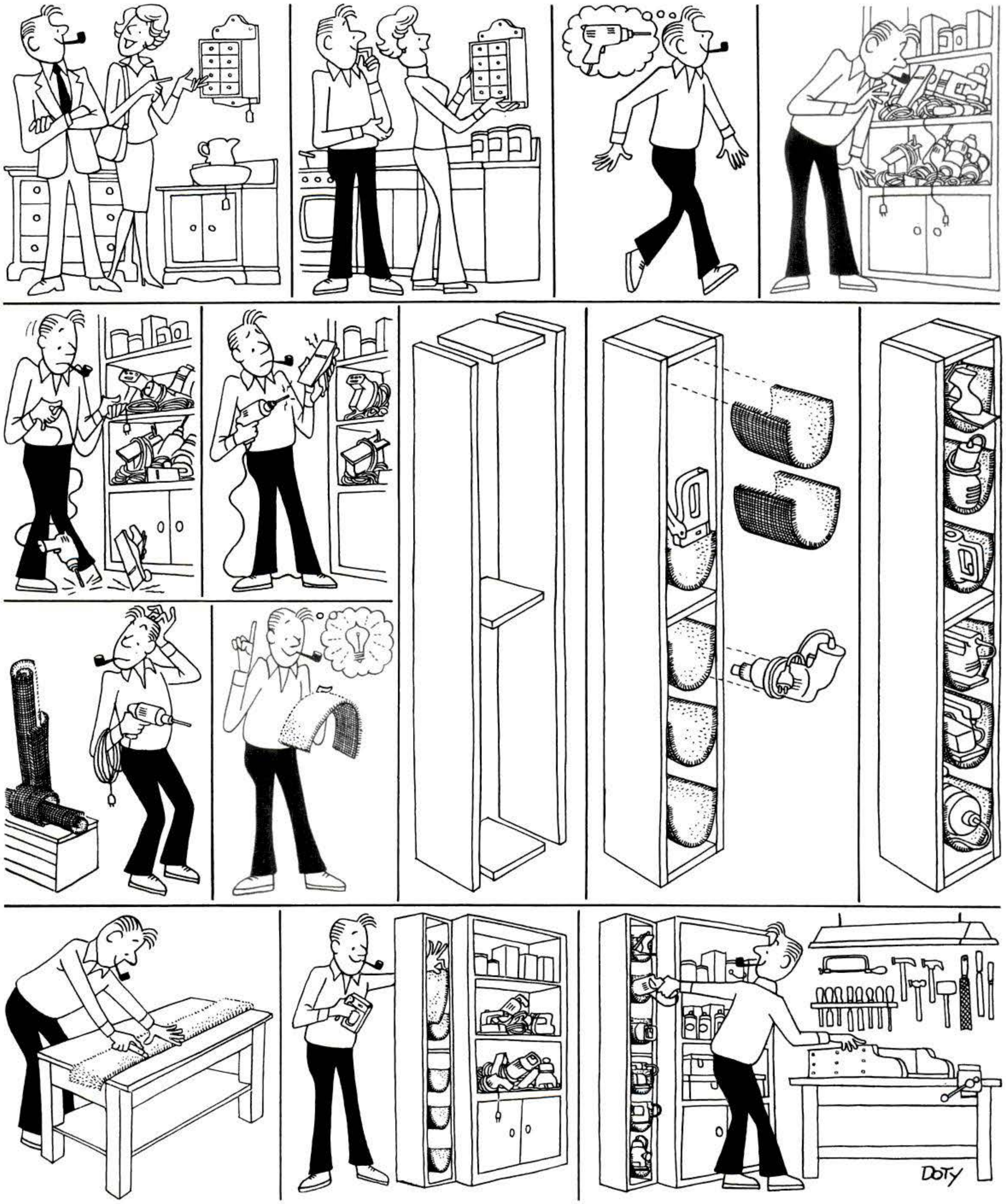

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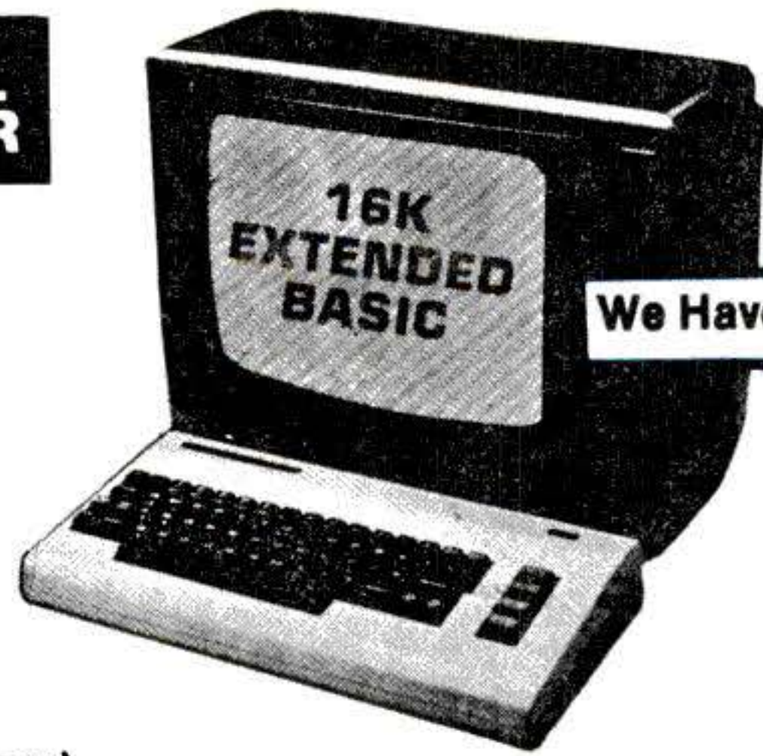

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For only $239.00 you get the COMMODORE VIC-20 Computer plus WE ADD 8,000 BYTES OF USER MEMORY to give you 2½ TIMES MORE PROGRAMMING POWER! This powerful full-sized extra featured computer includes the 6502 microprocessor (LIKE APPLE) 20,000 bytes ROM with a 16K extended LEVEL II Microsoft BASIC, 13,000 bytes RAM, a total of 33,000 bytes memory, plug in expandable to 60,000 bytes, 66 key typewriter professional expanded keyboard with graphic symbols on keys, color command keys, high resolution graphics, 512 displayable characters, text display is 22 lines 23 characters, sound and music, real time, upper lower case, full screen editing cursor, floating point decimal and trig functions, string arrays, scrolling, multi statement lines, file management, PEEK AND POKE. Assembly machine language is available. We have easy to use self teaching books and programs. Accepts TAPE-DISK AND PLUG IN CARTRIDGES, connects to any TV, includes AD adaptor, R.F. modulator, switch box, self teaching instruction book, comes in a beautiful console case.

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49K COMMODORE VIC $319 WITH SIX TIMES MORE POWER

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TRACTOR-FRICTION PRINTER $399

This all new COM-STAR deluxe line printer, prints 8½" x 11" letter quality full size, single sheet, roll or fan fold computer paper, labels, etc. 40, 66, 80, 132 columns. Impact dot matrix, bi-directional, 80 CPS. Includes special cable that plugs direct into the VIC-20 printer port — no other costly interface is needed! List $599. Sale $399.

SUPER 10" COM-STAR PRINTER $499

Has all the features of the COM-STAR printer shown above, PLUS! 10" carriage, 100 CPS, Dot addressable bit image graphics, 2.3 buffer, 18 character sets, 40, 48, 66, 80, 96, 132 columns, prints true descender, super and subscript, underlining. Includes special cable to plug into the VIC-20 printer port. List $699. Sale $499.

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Allows memory expansion to 60K total (20K ROM and 40K RAM). Has six slots to add six cartridges — you can switch select any combination of memory or programs. Stop and start any program with reset button, you don't have to remove cartridges or turn off computer. This expander is a must to get the most out of your VIC-20 Computer!

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WOW !! Plug in our new "GAME LOADER" and you can play all ATARI video game cartridges, Activision, Imagic M-Network on your VIC-20 computer. List $99. Sale $79.

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SHOP TALK

By AL LEES

Last chance for Lucky Seven: March 1 is the deadline

For the seventh year in a row, POPULAR SCIENCE (in cooperation with the American Plywood Assn.) is seeking fresh, well-designed projects that take advantage of the practicality and economy of softwood plywood. As we announced last November, your entry must be in Tacoma by March 1. Here's how to qualify:

● **PRIZES**: A $1,000 check will go to the top entrant in each of three major categories. There will be a secondary award of $250 in each category (total cash prizes: $3,750). An Honorable Mention winner in each category will receive a selection of how-to books from POPULAR SCIENCE Book Division—so you have nine chances to win and have your project published.

● **HOW TO QUALIFY**: Your project must be constructed from a stated amount of APA grade-trademarked plywood appropriate for the intended use: from ¼ to ¾ in. (thicker if required for structural strength); exterior type for outdoor or bathroom projects, interior type for indoor ones. Projects should be carefully designed for efficient layout of the plywood sheet or sheets you select; parts should be scaled, arranged, and nested to minimize waste. You may enter your project in any of our three categories, specifying which thickness you chose for your half (4 by 4 ft.) or full (4 by 8 ft.) sheets. Should you choose to enter the multiple sheet category, you have the option of using two or more different thicknesses if structurally justified.

In all categories, aim for minimum waste and minimum use of additional materials; non-plywood purchases must not exceed $100, and plywood should remain the dominant material. We're seeking functional, structurally sound design, but decorative or ingenious projects will also qualify if they represent an efficient use of the sheet or sheets you specify and if they can be built with home-workshop tools.

● **HOW TO ENTER**: Fill out our entry coupon, or list all information the coupon calls for on a separate sheet of paper—including a rough sketch of the APA-grade trademark(s) stamped on the back face or edge of the plywood you chose. Mail this with at least one clear photograph (black-and-white or color print is preferred, though color transparency is acceptable) plus a dimensioned diagram of how the project parts were laid out on the sheet or sheets. A crude pencil sketch will suffice if it's thoroughly and accurately labeled with critical dimensions. Please don't submit scale models, full-size cutting patterns, or plans sheets larger than 18 by 24 in. We also need a list of all materials used, grade and thickness of plywood, plus any lumber, hardware, and finishing materials (paint, stain, plastic laminate). Also jot down for us special construction tips you'd like to pass on to anyone attempting to duplicate your project. If no publishable photo exists, POPULAR SCIENCE and APA reserve the right to arrange photography at your convenience (and our expense).

Entries must be delivered to the Tacoma Post Office Box by March 1, 1983; upon delivery, publication rights belong exclusively to APA and POPULAR SCIENCE unless neither exercises this option within six months. Your project cannot have been previously published elsewhere.

Print the category you're entering (½ SHEET, SINGLE SHEET, 1½ TO SIX SHEETS) in the lower left corner of your envelope (one entry per envelope, please). No entries can be acknowledged, and none will be returned unless accompanied by a written request and a self-addressed envelope with sufficient postage (no checks or money orders).

● **JUDGING** (by PS Reader Activities Editor Al Lees and representatives of APA) will be for the most efficient and appropriate use of the sheet or sheets you chose. PS may publish dimensioned plans of those prize-winning projects we feel our readers might want to make. Plans for all nine winning projects will be available from APA after Sept. 1, 1983. Prize winners will be notified by April 15. Winning entries will be shown in our August issue.

ENTRY COUPON (Clip and attach to your plans sketch)

Mail entry to:
POPULAR SCIENCE CONTEST
Box 11700, Tacoma, Wash. 98411

To qualify, entry must reach Tacoma address by March 1, 1983

YOUR NAME (print or type) _____

ADDRESS _____ Daytime Phone No. _____

CITY _____ STATE _____ ZIP _____

Copy the plywood-grade stamp here

Description of project _____

Which category? ☐ ½ SHEET ☐ SINGLE SHEET ☐ 1½-TO-6 SHEETS

What thickness(es) plywood? ☐ ¼" ☐ ⅜" ☐ ½" ☐ ⅝" ☐ ¾"

If other, check here ☐ and specify _____

My signature certifies that this project is of my own design.

Sign here _____

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Insulating an entry door

Reader R. E. Heidebrink writes me from Cincinnati:

"Each year I try to tighten up my house to conserve more energy. I've now done most of the things PS has recommended—beefing up attic insulation, renewing weatherstrip, sealing storm windows—but my 20-year-old home still has some heat leaks.

"I realized that my front door had been cold to the touch all winter, so on a relatively mild day I tapped the pins out of the hinge barrels and propped the door up on its latch edge. I drilled several ¾-inch holes through the hinge edge and probed inside the panel with stiff wire. As I suspected, it was a hollow-core door. So I put a funnel into the edge holes, one by one, and poured granular insulation into each cavity, making sure each was full by tapping the faces to settle the fill. I then plugged the holes by gluing in pieces of ¾-inch dowel before I rehung the door. The core fill has increased the door's R-factor by 3.6, and the inside face stays at room temperature, even on our coldest nights."

Twist-proof knobs

Wooden drawer knobs are usually attached with a screw or bolt through the center. In time, they work loose enough to turn free. To stop this, remove the knob and drive two brads into the back, on each side of the screw hole. Cut off their heads with a diagonal cutter, leaving protruding studs. When you replace the knob and snug it up, the brad points will bite into the drawer front and keep the knob from twisting loose.

Fun from the sun

I've just leafed through a 28-page workbook titled "Using Solar Cells" and find it a clear and simple introduction to photovoltaics. It includes a brief history of solar cells, tells how they're made and how they work, explains that an undamaged cell has a useful life of about 20 years, and then shows how to wire cells together to make panels that will run a fan, power a small transistor radio, recharge nicad batteries, and so on. The sketches, though crude, are adequate. You can order a copy from Mr. Sun, Airport Rd., Alexandria, Minn. 56308; send $3 plus $1 for first-class mailing.

On the subject of photovoltaics, I'm just back from a trip to Epcot Center—that "permanent world's fair" near Florida's Disney World. One of its most impressive features is Exxon's Energy Pavilion, with an array of 80,000 solar cells on its roof. They're not for show. Inside, there's a huge theater where, after an introductory film is projected on a 360-degree screen, the seating sections unexpectedly split up into big flatcars and go tootling off, one after another, to tour a vast, animated diorama of the Mesozoic age. This unique people-mover is powered by those cells on the roof.

I'll have more to tell you of Epcot's wonders once I've caught my breath. PS

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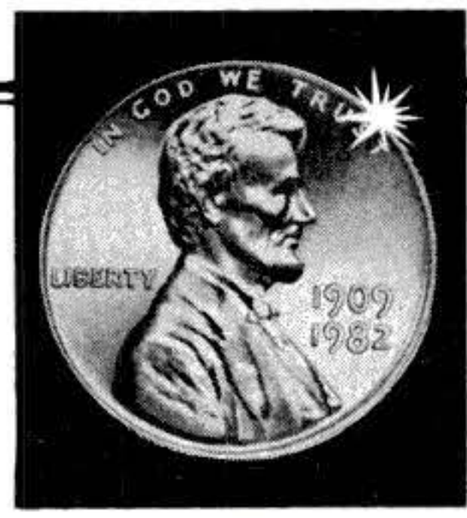

Valuable rare Lincoln miniature penny in solid 14-karat gold. Enlarged to show detail.

January, 1983, Philadelphia, Pa—The U.S. Government announced recently that 1982 will be the last year for minting the copper Lincoln penny. And already these vanishing historic coins are being hoarded by wise collectors and investors. Thus creating a severe shortage, which in turn, will have a dramatic impact on future value.

The International Mint, however, announced today that a limited number of 24-coin complete date sets of valuable 95% copper Lincoln pennies are available for immediate acquisition by readers of this publication at the low price of just $12.95 per set. The coins cover every date struck by U.S. Government Mints. Each coin is flawless in Brilliant Uncirculated condition. A deluxe album is included at no additional cost.

To commemorate the last 1982 striking of the copper Lincoln penny, International Mint will send to each purchaser of the 24-coin Lincoln collection a magnificent 9mm solid 14-karat gold Lincoln penny absolutely FREE. This free gold coin offer is valid only as long as International Mint's limited supply of the 24-coin sets lasts.

To qualify, call Lee Collins toll free at 1-800-345-8502, Dept. **BQ-1535** (in Pa., call 1-800-662-5180) and charge your acquisition to any major credit card. Or send your name and address, plus $12.95 for each collection (LIMIT:5) to **International Mint, Dept. BQ-1535, 390 Pike Road, Huntingdon Valley, PA 19006.** Please add $1.75 to cover insurance, handling and postage. If not completely satisfied, you may return your 24-coin complete date set within 14 days for prompt refund of full purchase price (except postage and handling,of course). In any event, the solid 14-karat gold commemorative Lincoln penny is yours to keep. An $8 value.

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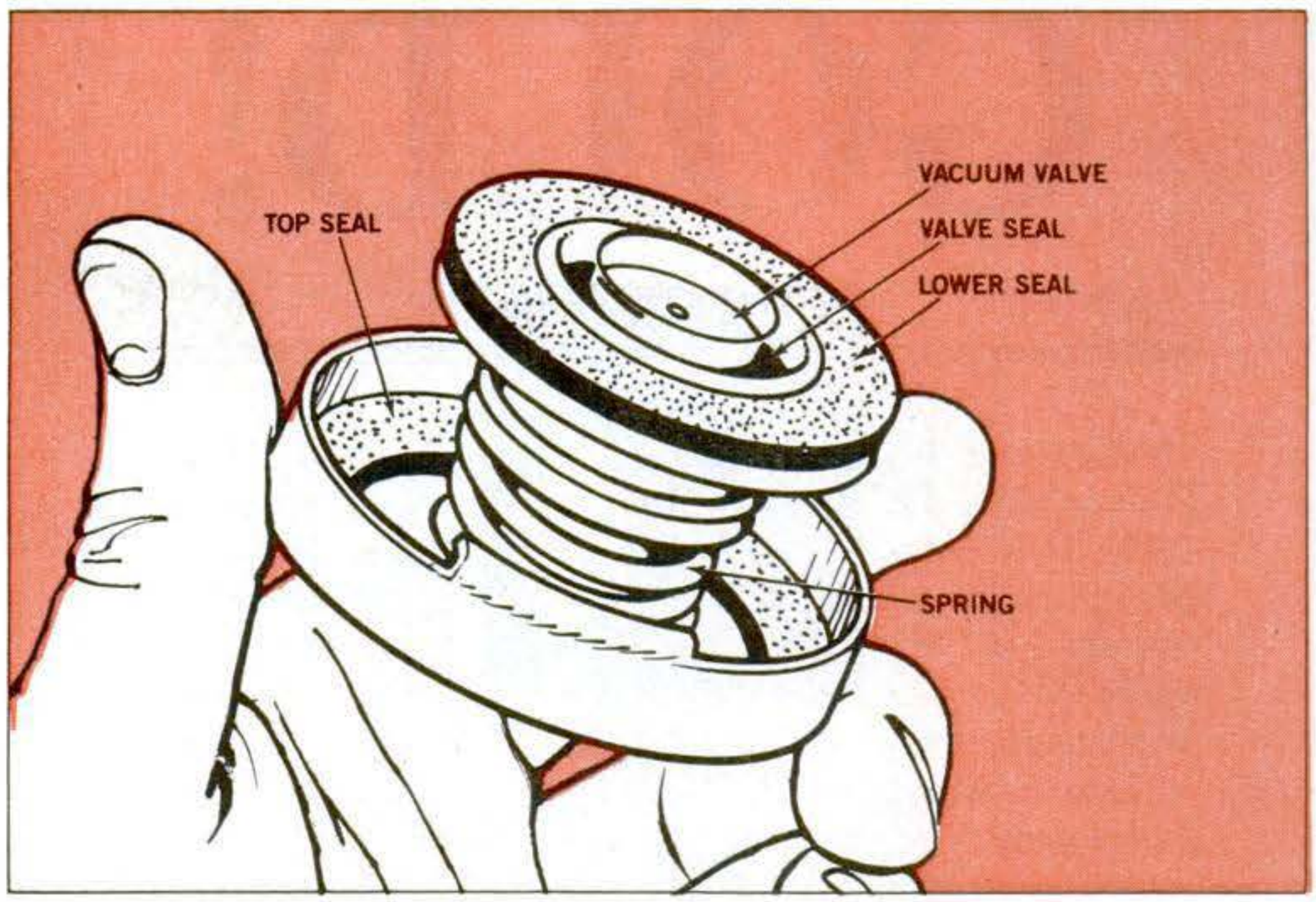
TAKING CARE OF YOUR CAR

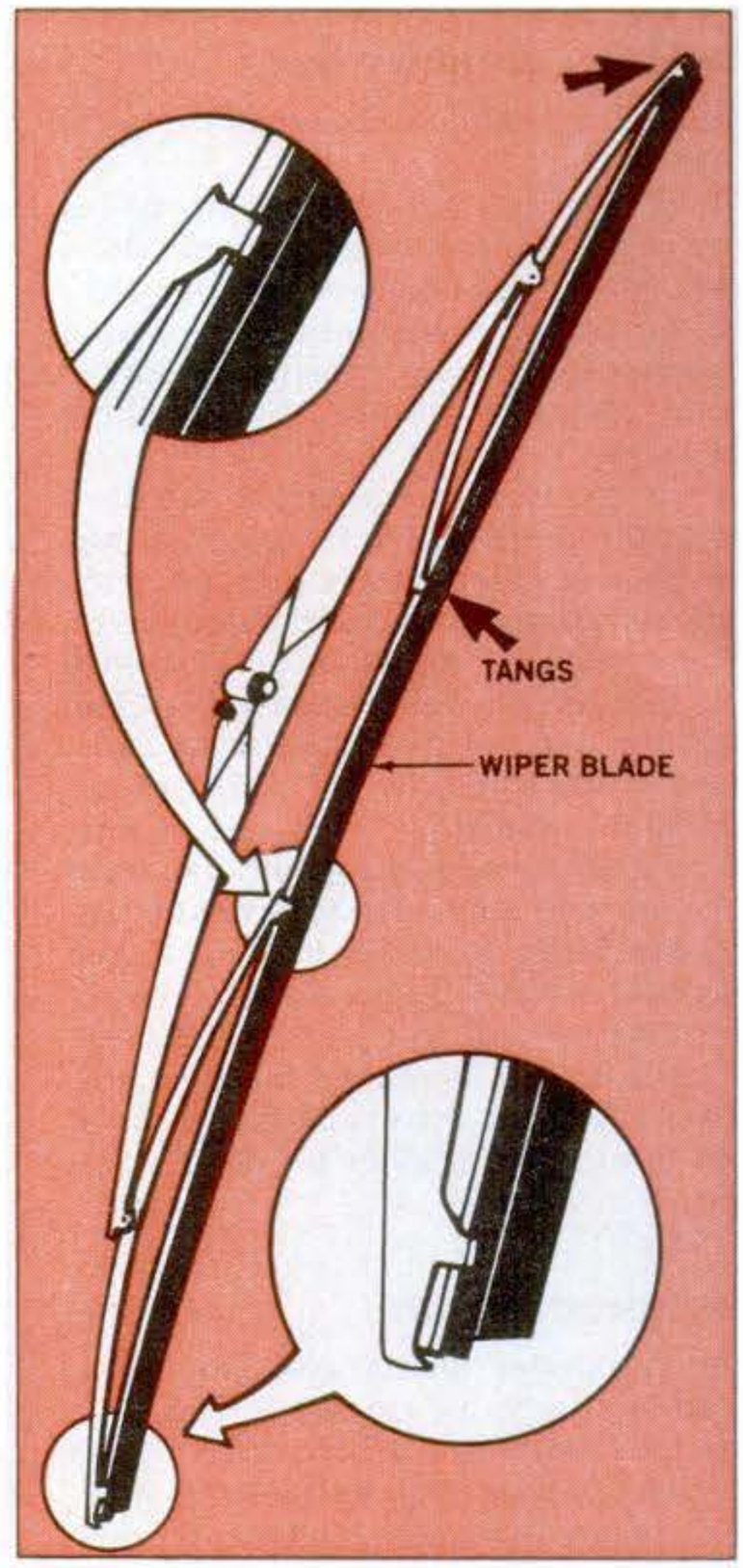
By STEVE MERCALDO

Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



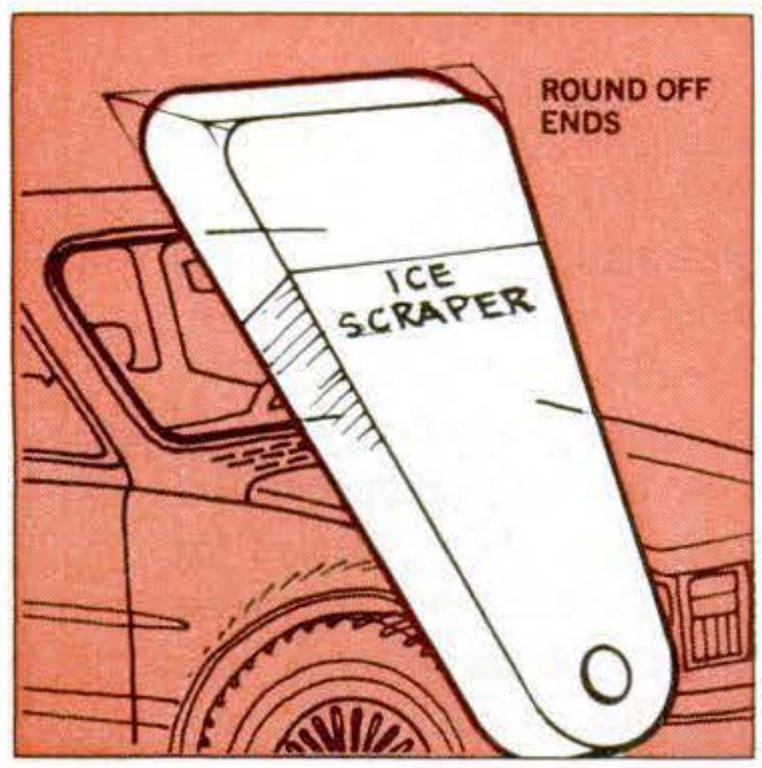
Don't neglect your radiator cap

Radiator caps need periodic inspection and cleaning. Begin by inspecting the pressure spring. If the coil spring is broken, replace the cap. Next, check the rubber seal for cracks and swelling. Insert the cap into the radiator filler neck. It should fit in loosely. If the seal is tight in the filler neck, the cap must be replaced. Continue the inspection by raising the rubber seal and vacuum valve with your fingers. With water, flush away any loose dirt or rust under the seal, vacuum valve, or on the sealing surfaces. Scrape away any stubborn debris that the flush does not remove. Finally, have the cap pressure-tested at a service station.



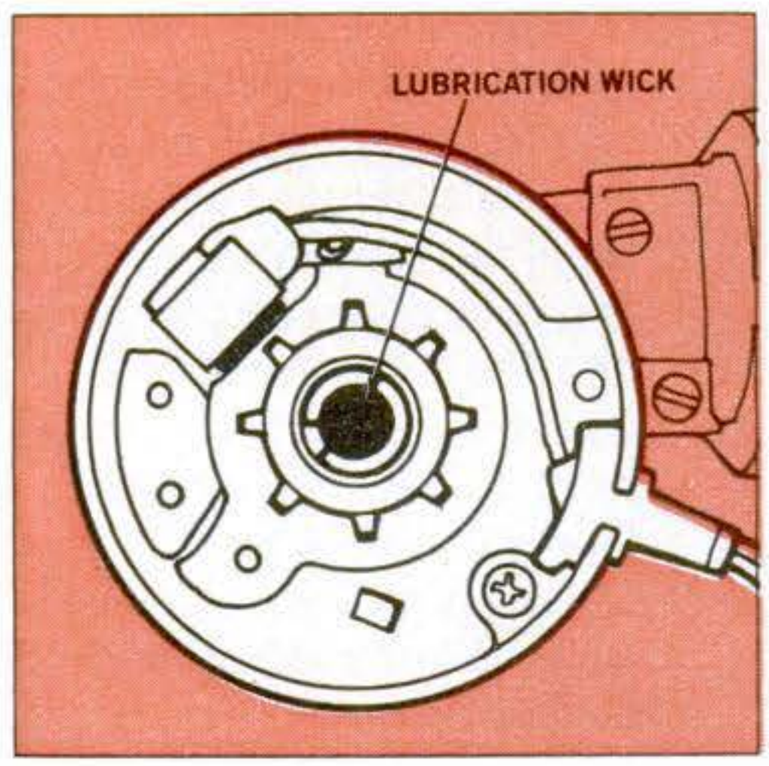
Watch those wiper tangs

When installing wiper refills, it's easy to miss one of the securing tangs, which are part of the metal wiper assembly. To avoid that, always remove the wiper assembly from the arm when installing a refill. After the refill is in place, make sure each tang has been secured around it. This could prevent a windshield scratch.



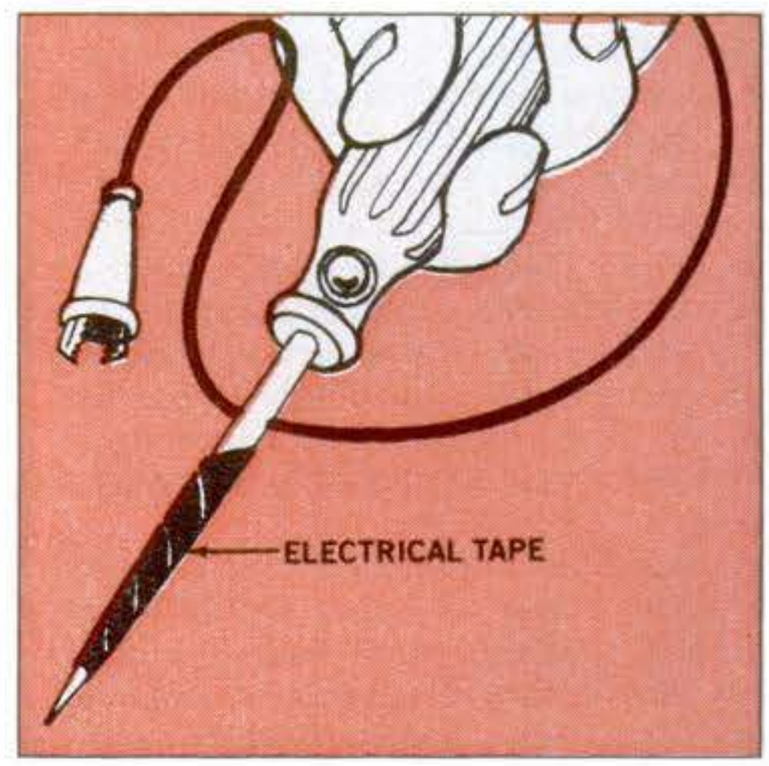
Scraper's edge

Plastic ice scrapers are great for quickly removing heavy accumulations of ice and frost. However, the sharp edges of the scraper blade can get caught on the rubber weatherstrips around windows. Damage to any of these sealing surfaces can cause water leaks and severe wind-noise problems. To avoid replacing your car's rubber weatherstrips, round the edges of the scraper as shown with a wood file.



Distributor lubrication

Many distributors are equipped with a small felt wick that must be lubricated during every tuneup. Simply remove the rotor and apply several drops of 10-weight oil to the wick. The wick supplies proper lubrication between the distributor shaft and centrifugal (mechanical) advance assembly. Failing to oil the wick can result in a frozen mechanism and improper ignition advance.



Short-circuit prevention

A 12-volt test lamp is a handy tool for trouble-shooting a faulty bulb socket. To prevent the test-lamp shaft from accidentally short-circuiting by touching the socket housing, simply wrap a piece of electrical tape around the shaft. Remember to leave a small section of the tip exposed. Now if the test-lamp shaft should come in contact with the housing, it won't short the circuit and blow the fuse.

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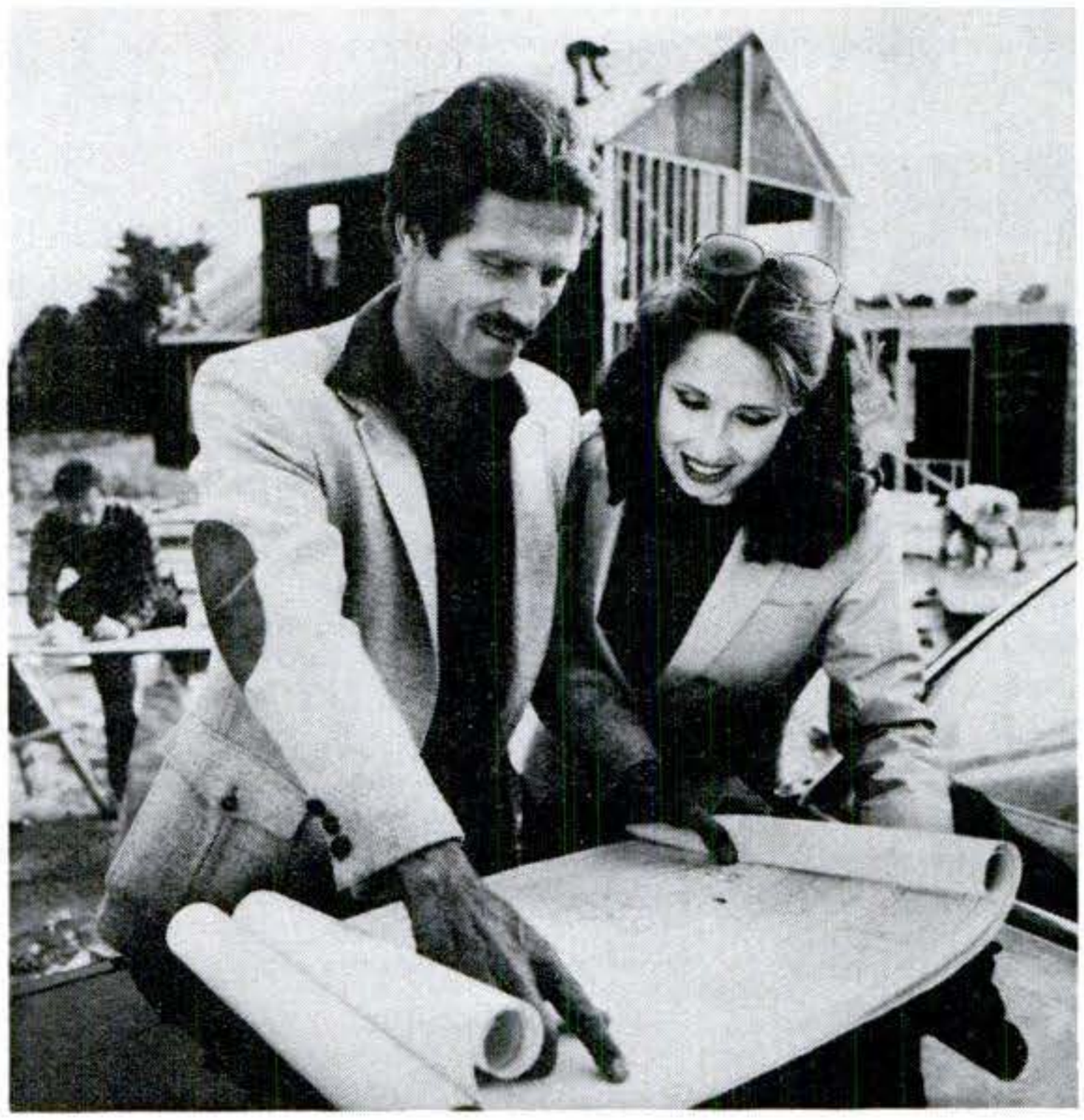

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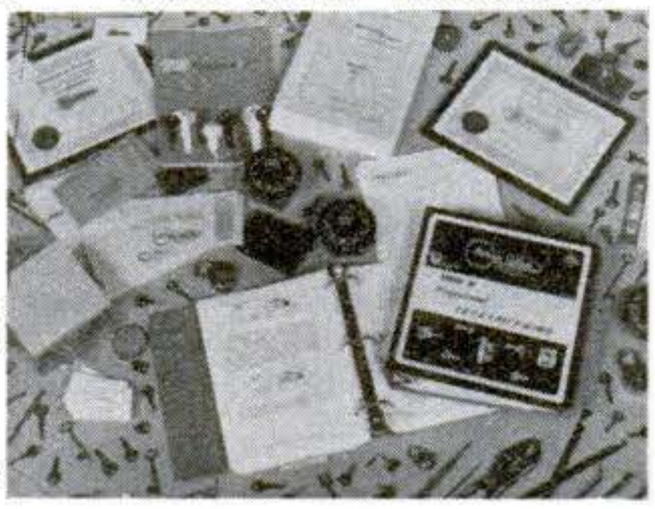

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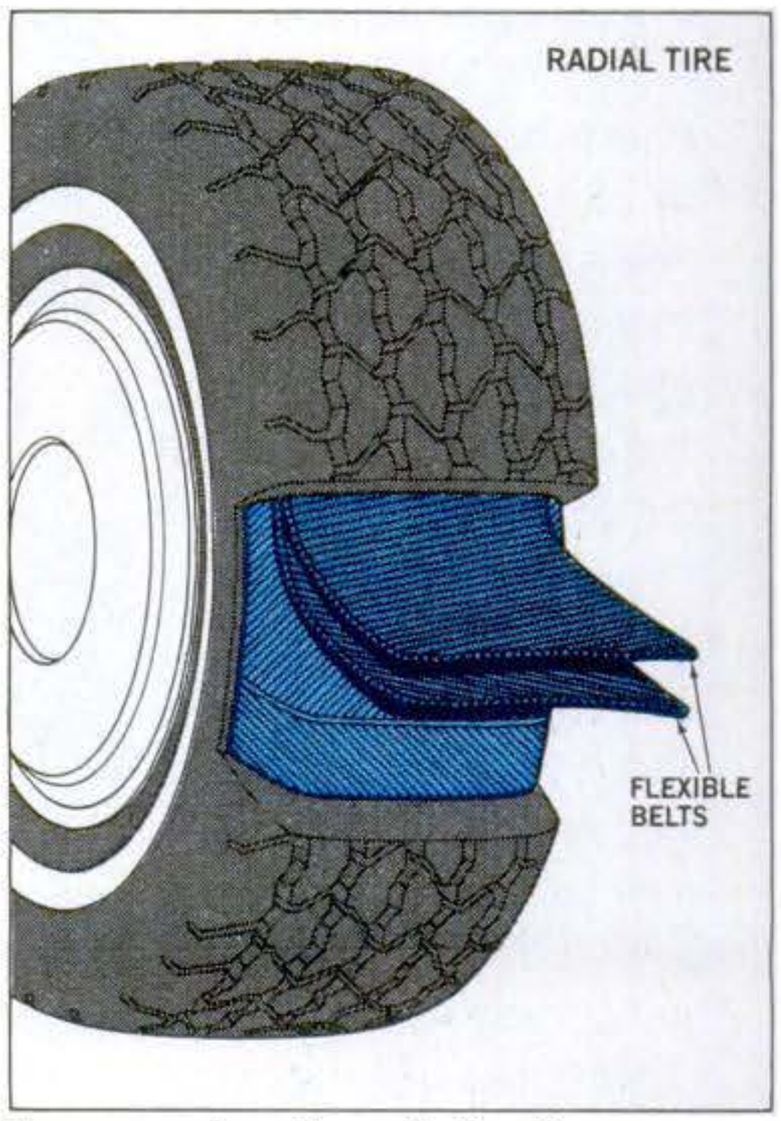
Automotive quiz

[Continued from page 100]

tion-related since the engine loses spark, but where is the faulty part? What's causing the engine to stall?

Answers

1. Frank has it right. A defective front radial tire can cause severe pulling. Radial tires are constructed with several belts positioned directly under the tread area. Normally these belts stay in place during the life of the tire,



but occasionally a belt slips to one side, causing a noticeable pull. Once this happens, the tire should be discarded. Preventive maintenance usually stops this from happening: Keep tire air pressure at the recommended pressure, and have the front-end alignment and wheel balance checked at least once a year.

Lou was correct in saying that the front-end caster angle was not set to specification, but that wasn't the cause of the pull to one side. It's true that the caster angle is a directional control and can cause a pull if not set correctly, but it happens only if the angles are not the same.

2. The collapsed lower radiator h se is the cause of the overheating. A lower radiator hose must have a spring inside it to prevent the hose from collapsing during high engine rpm. The hose on this engine was missing its support spring.

Continued

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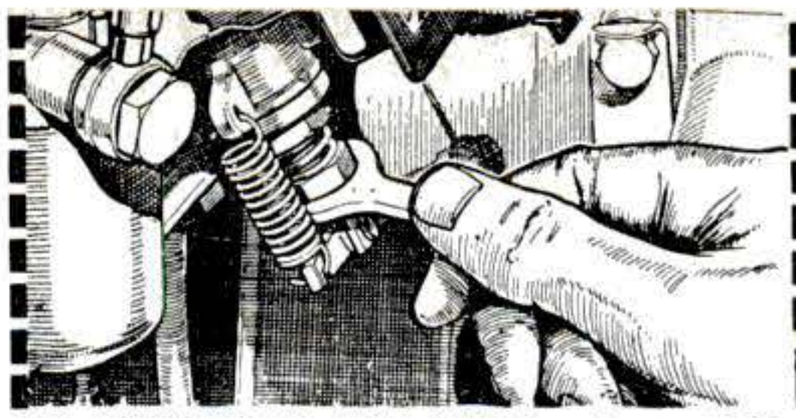

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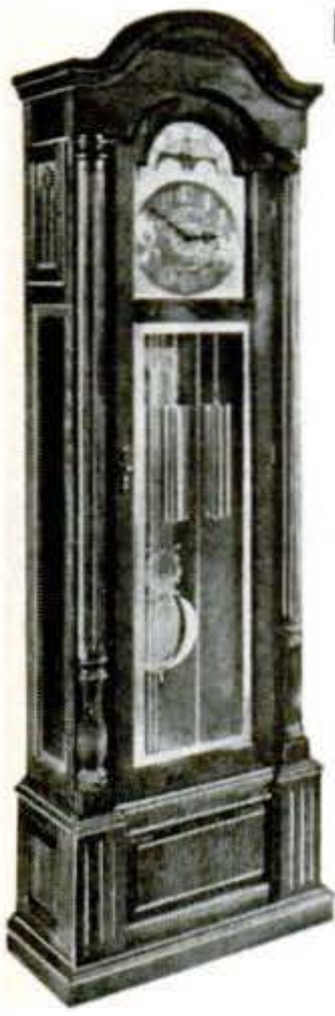

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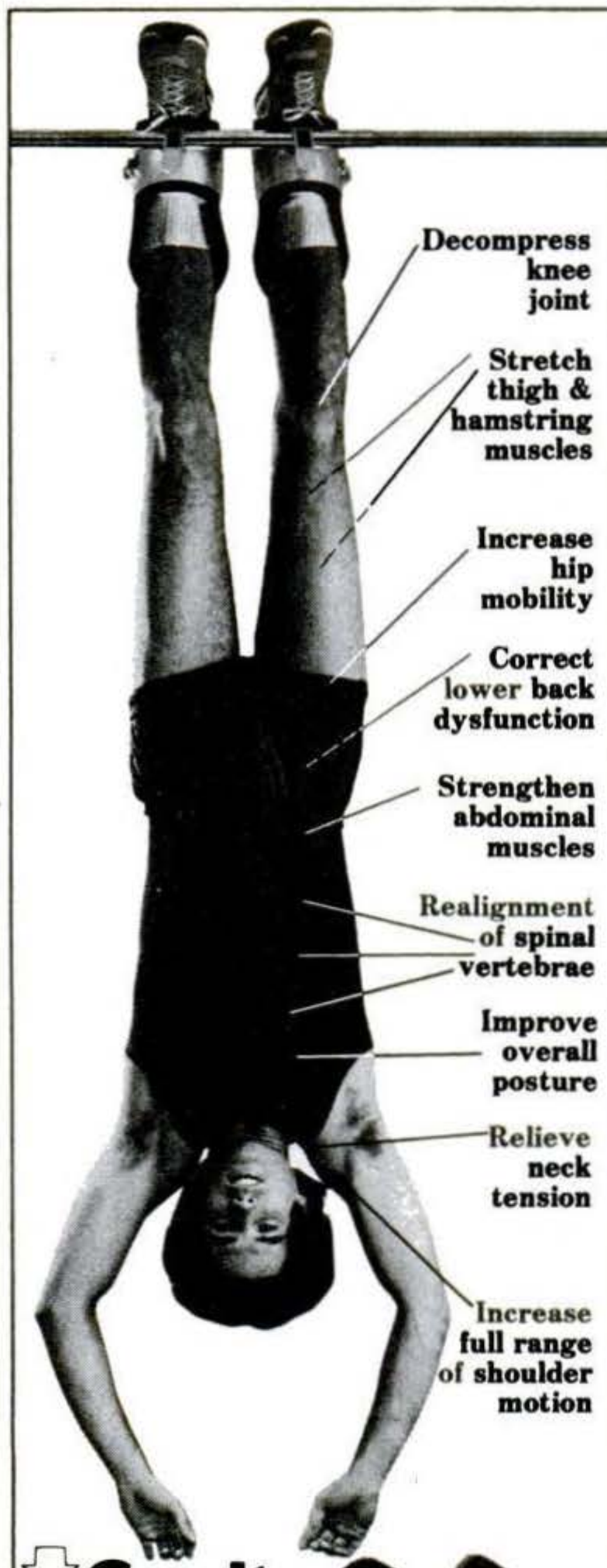

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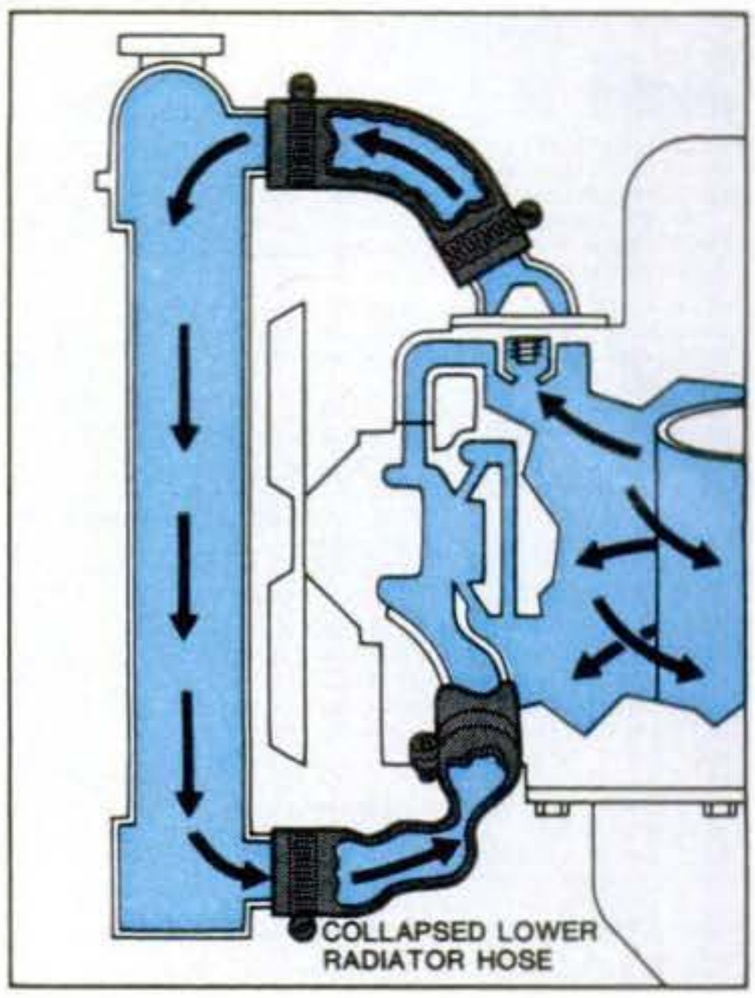
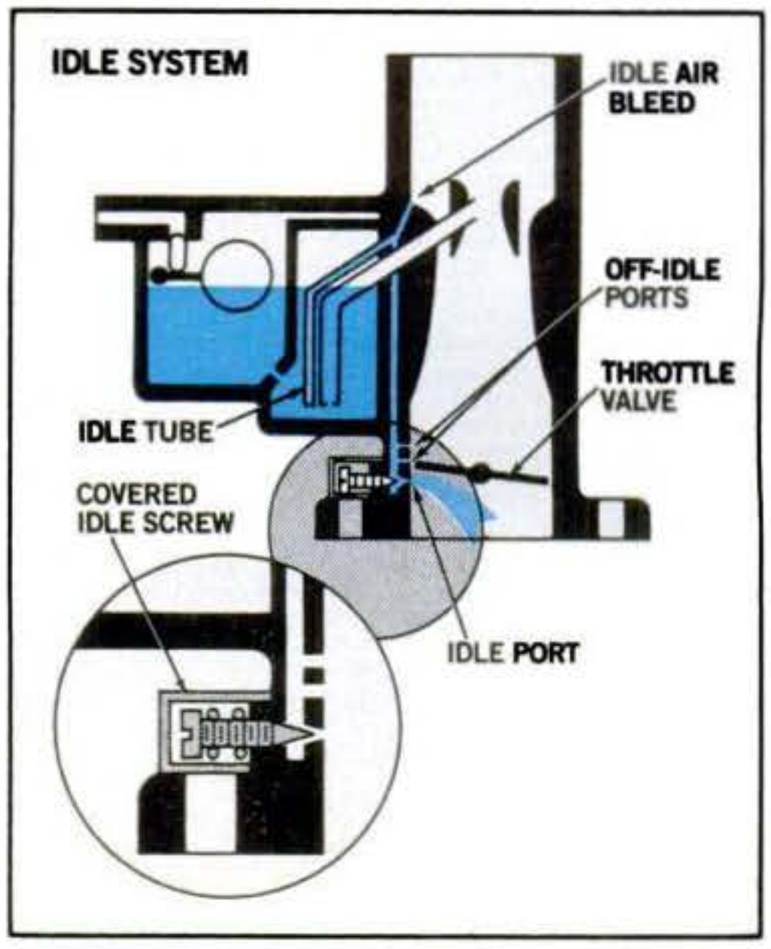


Why does the hose need a spring? Coolant is circulated by a water pump, which draws from the bottom of the radiator through the lower radiator hose. At high engine speeds the pump moves approximately 60 gallons of coolant per minute through the lower hose. The suction can collapse the hose unless it's held open by a spring inside it. Hoses are available with a separate spring or with one that's molded in.

3. The carburetor idle circuit is too lean to maintain a smooth idle.

Carburetor-choke cleaner in a spray can is useful for pinpointing the cause of a lean idle fuel mixture. In this particular case, the engine only responded to the spray when it was introduced directly into the carburetor air horn. That pinpointed a lean idle mixture. Sometimes an idle-mixture-screw adjustment corrects a lean idle mixture, but since the mixture



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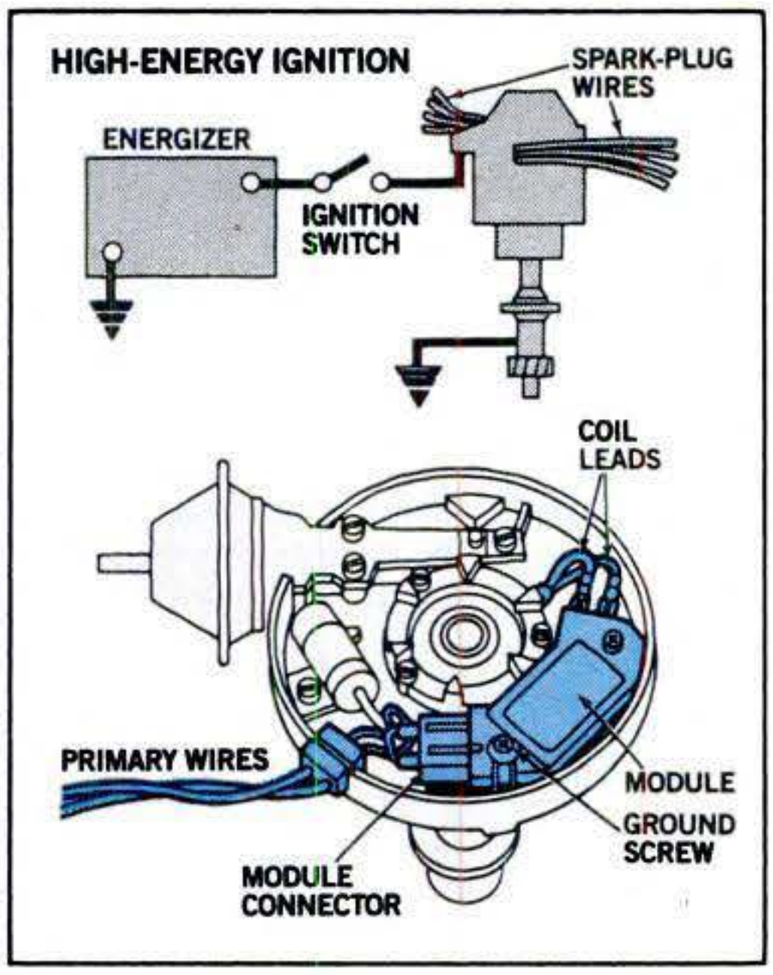
screw was plugged, the next best step is to take the vehicle to a qualified mechanic. He can remove an idle-screw plug and reset the mixture according to the manufacturer's recommendation. If the adjustment doesn't cure the problem, the carburetor must be rebuilt or replaced.

4. The electronic-ignition module is defective. It's not uncommon for an electronic-ignition module to break down when exposed to high engine-compartment temperatures. When such a breakdown happens, the engine either shuts down or begins to run roughly. Cooling the module by opening the hood can sometimes bring it back to life, eliminating the problem temporarily.

You can buy special equipment to test an electronic-ignition system and isolate a bad module, but this can be expensive. It's not the kind of equipment you'd find in a weekend mechanic's toolbox.



The best (and least expensive) method to pinpoint this problem is by a process of elimination. Check all the other parts in the system and, if they're functioning, change the module. Most electronic-ignition systems can be tested with an ohmmeter, voltmeter, and jumper wire, following directions in a good repair manual.

The car owner in this instance followed the procedure for testing the GM HEI. Input voltage, distributor, pickup coil, ignition coil, and all the wires passed the test. The only part not tested was the module; changing it will prevent the unexpected engine failure from occurring again. PS

What you should consider before you invest in...

Ultrasound Pest Control

DeciMate has proven effective in tens of thousands of homes and plants. We sell only the "500C", the top model of the line. It features the most sophisticated electronic circuitry and high performance speaker system. It protects 3,500 ft.^{2} (25,000 ft.^{3}): There are many imitators, but there is nothing like the *DeciMate* 500C.

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There is no longer any question: ultrasound of the right frequency range and of appropriate decibel output is the most effective means of ridding your home or plant of pests and varmint once and for all. An ultrasound generator will rid your home or your plant forever of mice, rats, roaches, bats, fleas, spiders and other nastiness. A properly designed unit is totally inaudible to humans and pets, and cannot harm them. But it will totally disrupt the eating, sleeping and reproductive habits of pests and varmint and will cause them to leave your property forever -- within two weeks or sooner. A well-designed unit should protect at least 3,000 ft.^{2} or 20,000 ft.^{3}.

But an ultrasound pest control unit is unlike anything that you have ever bought. You see a tiny light flash and you hear a click when the unit cycles -- but that is all. Obviously, you can't hear the ultrasound (or you certainly shouldn't!) and you don't see anything dramatic happen. No roach or mouse will drop dead in front of you. In other words, you have to buy it pretty much on faith, backed up by a few facts that you can check out.

Here are some of the questions that you should ask yourself:

- Has the firm selling the unit been in business for many years -- do they have customer acceptance and confidence? Do they have a good BBB rating?
- Does the unit have the endorsement of the EPA (Environmental Protection Agency) and of City Building and Safety Departments?
- Is the unit listed and approved by Underwriters Laboratories (UL)?
- Has the unit proven its worth and efficacy in tens of thousands of homes and plants or is it a Johnny-come-lately without any record of performance?
- Does the unit have two levels of output intensity -- for day/night use and for severity of problem?
- Does the unit protect 3,500 ft.^{2} (25,000 ft.^{3}) or only 1,500 - 2,000 ft^2?
- Does the unit sweep the entire ultrasound range -- from 25 kHz. to 65 kHz. -- thus covering the sensitivity range of all varmint that you want to get rid of?
- Are the electronics of the unit so meticulously engineered that no stray lower frequency waves are generated that could be annoying or possibly even harmful to humans or pets?
- Does the unit have at least 150 dB ultrasound intensity output?
- Is the unit designed so that it can run continuously with minimal power consumption (less than 5 watts) and will not cause overheating and be a fire hazard in your home?

The reason you should ask yourself these questions is that this is obviously a field in which fly-by-night operators and quick-buck artists can thrive. You should not buy an ultrasound pest control unit if your answer to even one of these questions is "no" or even "maybe".And you should not be deterred even if you can get a "bargain" and if you can save a few dollars. You are buying something that is supposed to do the proper job and that should last you for 10 to 20 years. You should only buy a unit for which all the answers to the above questions are a resounding "yes".

DeciMate is the only ultrasound pest control unit that passes every test and gets a clear-cut "yes" answer to every question. Tens of thousands of delighted users have rid their homes or plants of pests and varmint forever. And they have done it without noxious poisons that can endanger the health of your family and to which those pests are likely to become immune anyway, in just a few generations -- and that can take as little as two or three months.

Rid your home once and for all of pests and varmint that make life miserable and endanger your health. Do not be deceived into buying a "bargain unit" that at best may be quite inneffective. Go with the leader, the pioneer in the ultrasound pest control field, the unit that has rid tens of thousands of homes of pests and varmint forever. Order *DeciMate* today!

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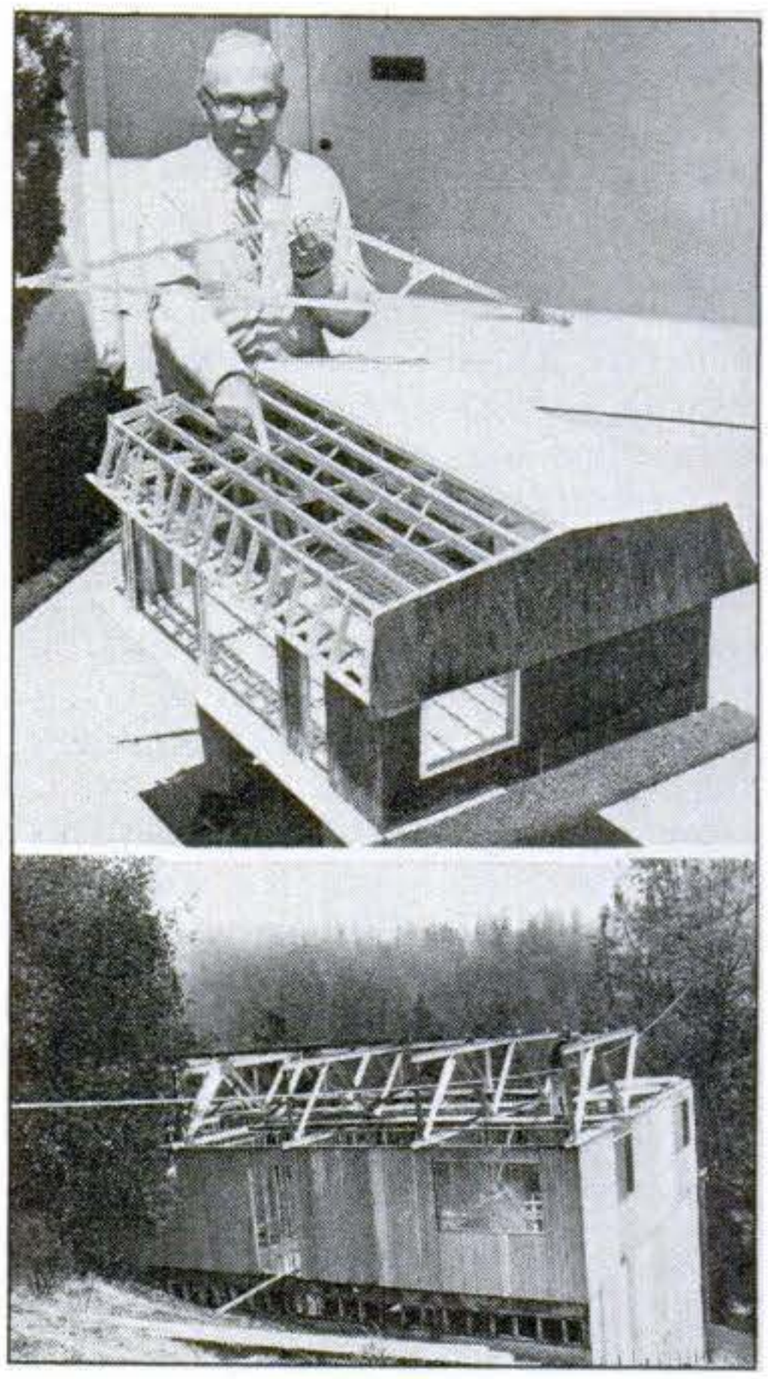

A system of aluminum roof trusses for homes can cut building costs in half, says San Francisco designer Tom Heeney. Made of extrusions supplied by Kaiser Aluminum, the trusses can be shipped to the home site pre-assembled or in pieces for bolting together later.

Heeney sets his trusses on wooden pillars spaced eight feet apart. Since the trusses can span up to 30 feet, no center supports are needed. Result: a house with no load-bearing outer or inner walls and 80 percent of conventional supports eliminated.

This allows eight-foot wall sections to be prefabricated and swung into place. Interior partitions can be placed to form an infinite variety of floor plans. They can even be shifted around later.

Using this system, four men can put up the walls, put on the roof, and erect the partitions of a 1,200-sq.-ft. house in two days, Heeney claims.

The trusses can be shaped for either a pitched or a mansard roof and are designed for loads of up to 20 pounds per square foot. Wooden purlins connect the trusses to any type of roof decking, but Heeney recommends prepainted aluminum structural roofing.—*Erik H. Arctander*

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It's like having X-ray ears...

Tiny, powerful electronic "ears" let you hear whispers through walls, conversations 2 miles away.

The Dyna-Mike Transmitter

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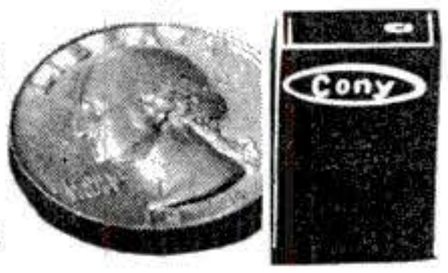

If you're at a neighbor's home a block from your own, you can hear your baby's cry, or you can tell the instant your spouse comes home. If two of you are driving tandem in two cars, one or both of you can communicate with the other even if other cars drive between you.

DYNA-MIKE has as many uses as your imagination can think of. For a business conference, let the tiny microphone sit unobtrusively on the table or concealed on a shelf, and you'll be able to record every word. For businesses, you can put an FM receiver in a warehouse or remote office and "broadcast" instructions or orders to be filled.

Public speakers never had a better friend than the DYNA-MIKE. No wires or setup — just turn on one or more radios and your speech will come through with perfect fidelity. Put one on the front porch. If you hear a suspicious sound, turn on the radio and you'll hear the doorbell or the ring of the telephone.

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Model X-3 is the most sensitive microphone. It broadcasts perfect-quality sound even from low-levels or whispers, up to 1,500 feet. Introductory price is $99.95 (two for only $89.95 each).

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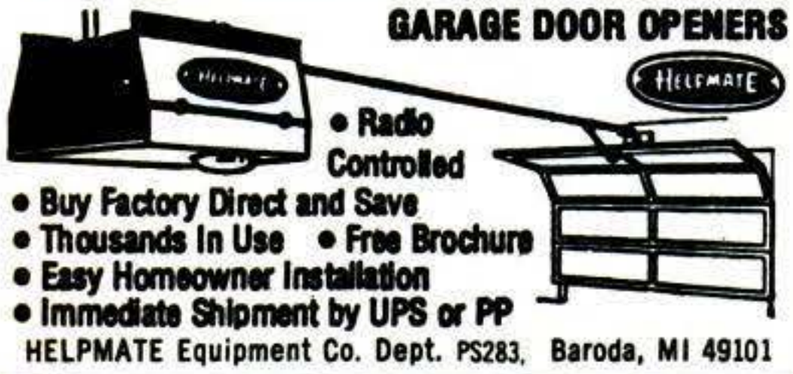

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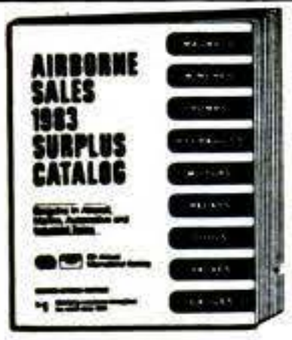

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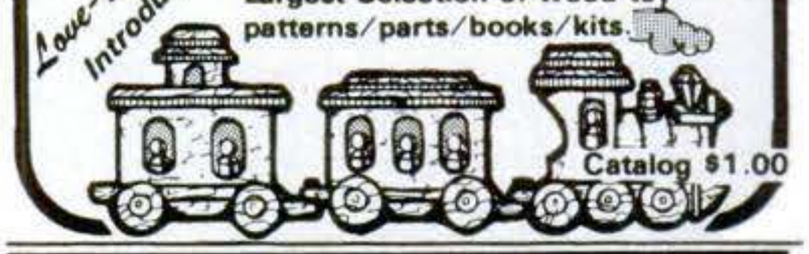

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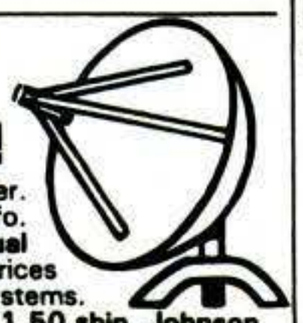

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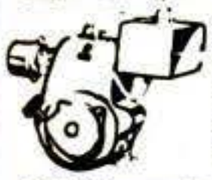

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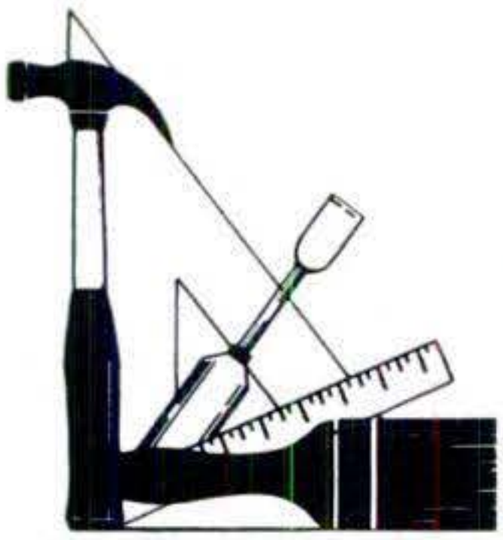

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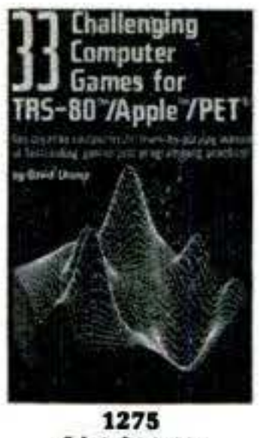

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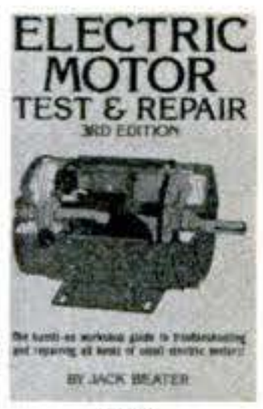

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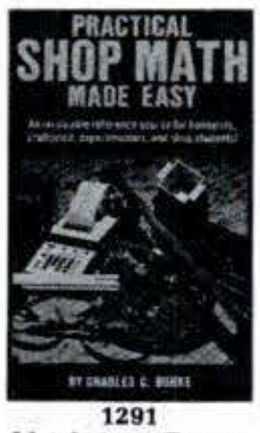

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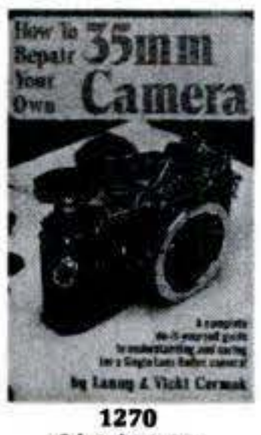

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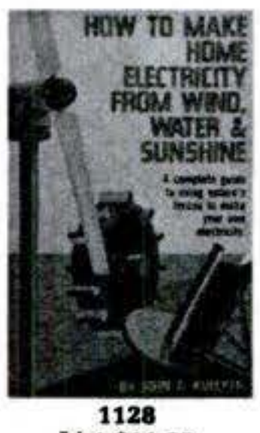

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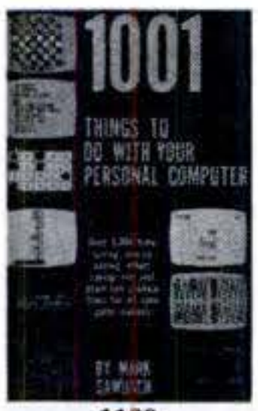

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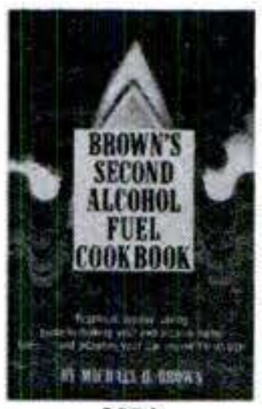

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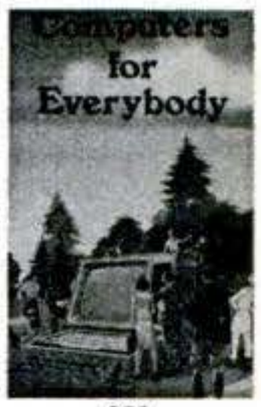

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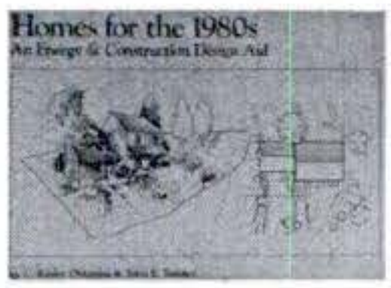

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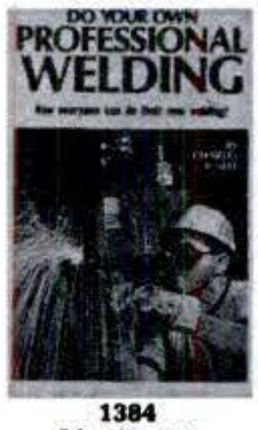

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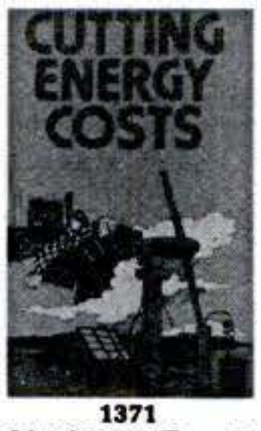

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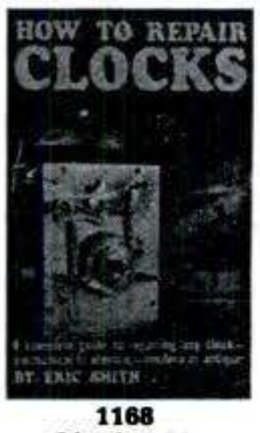

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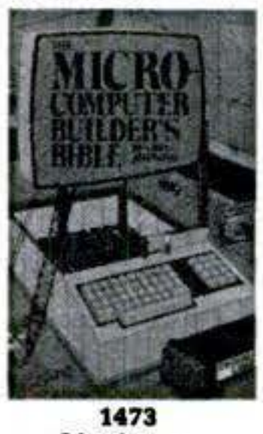

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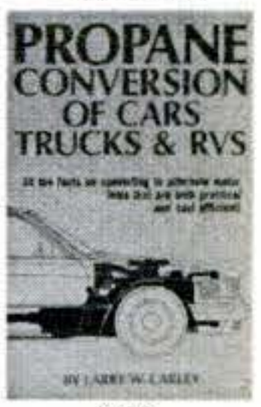

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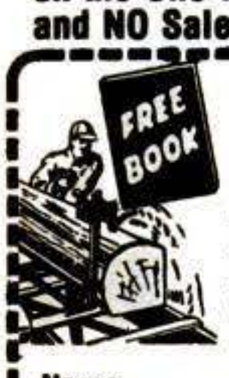

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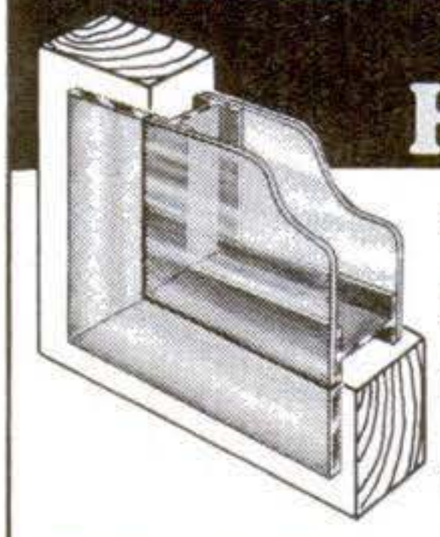

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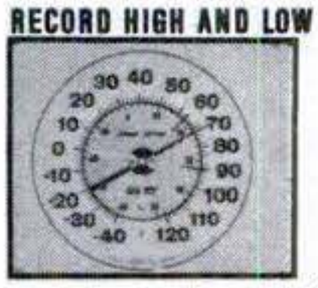

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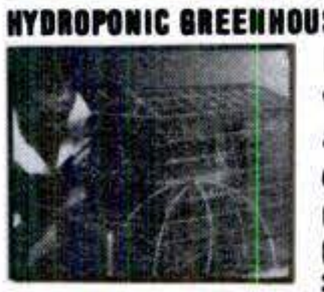

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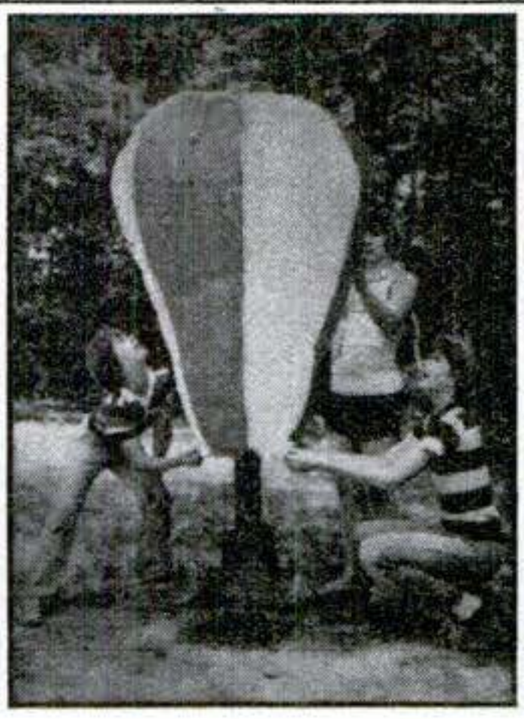

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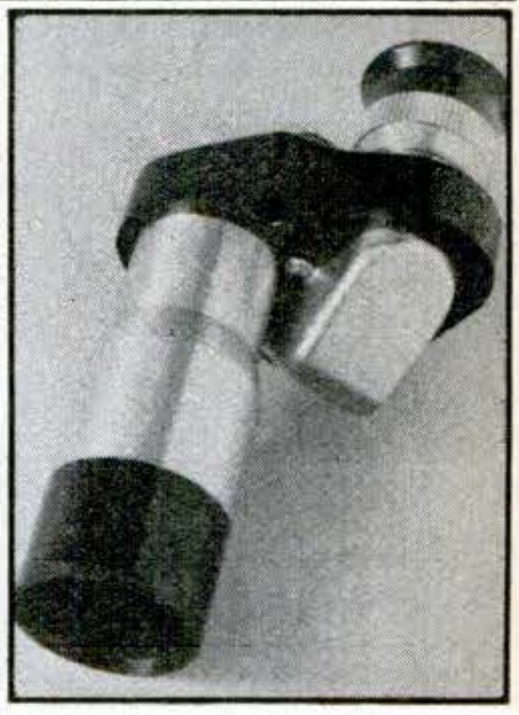

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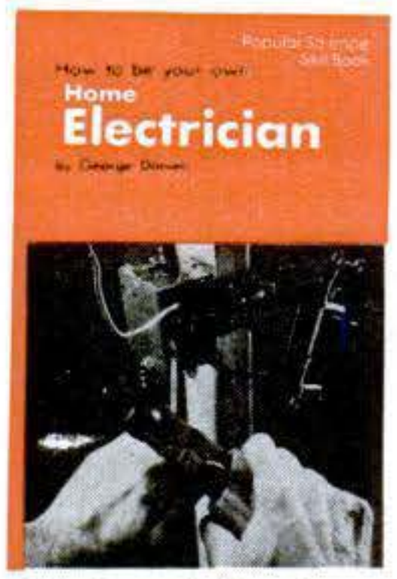

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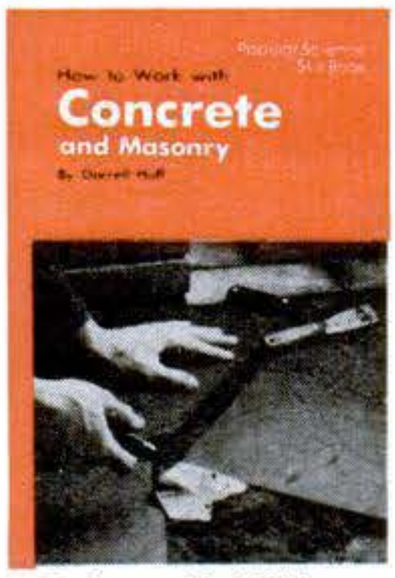

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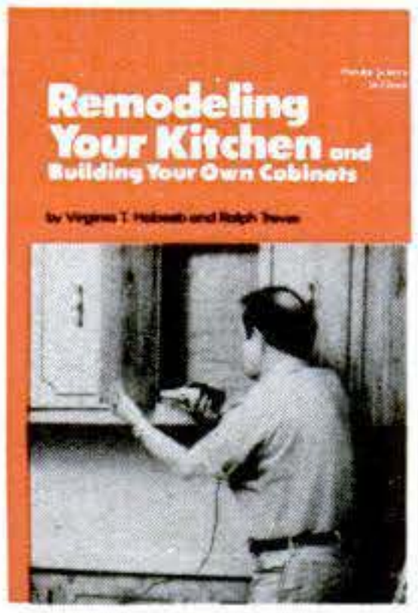

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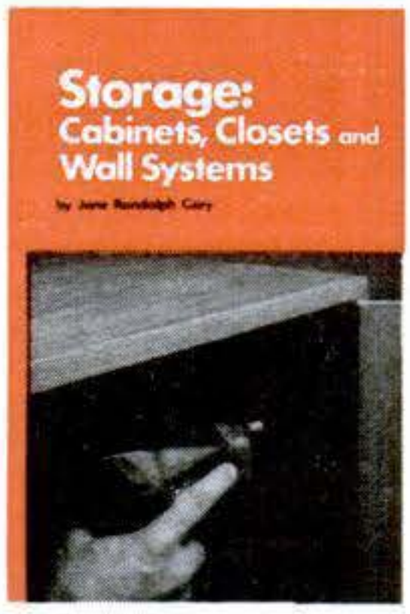

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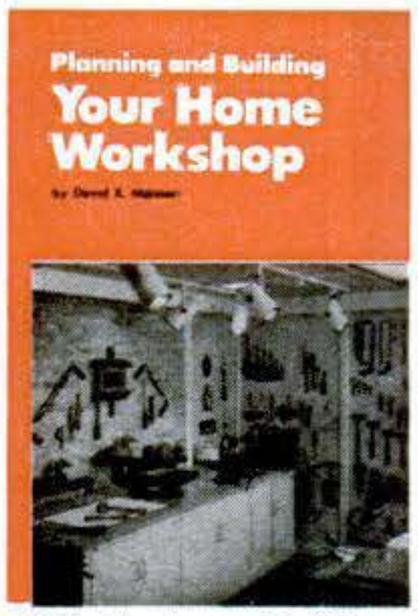

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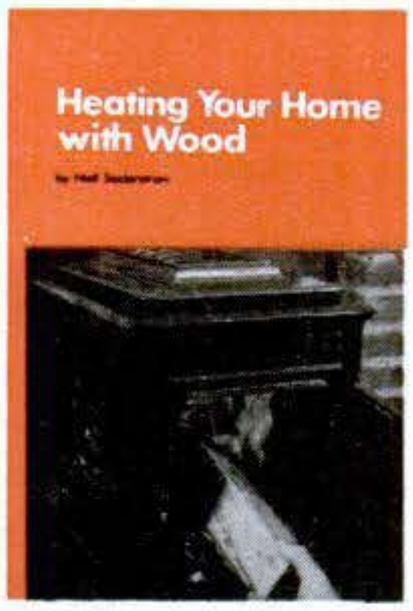

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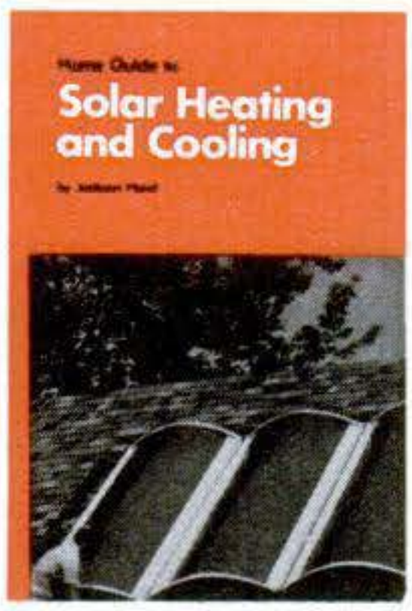

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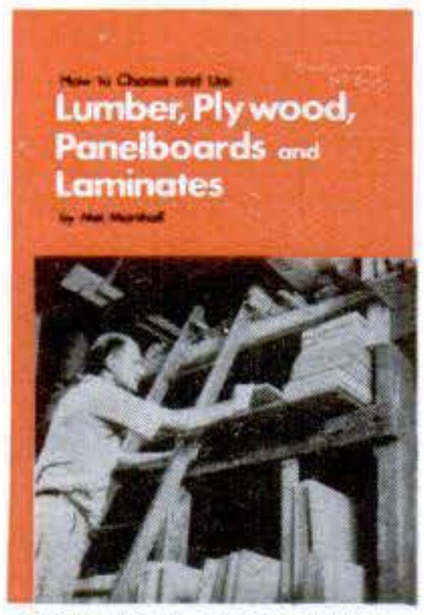

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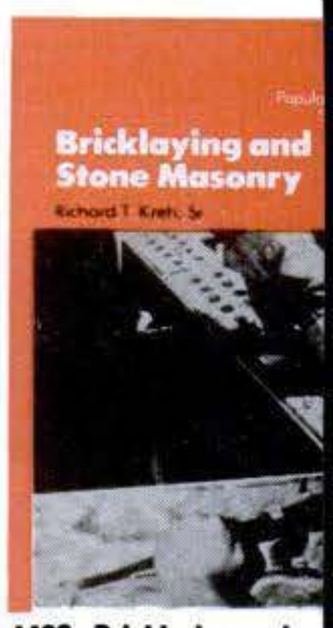

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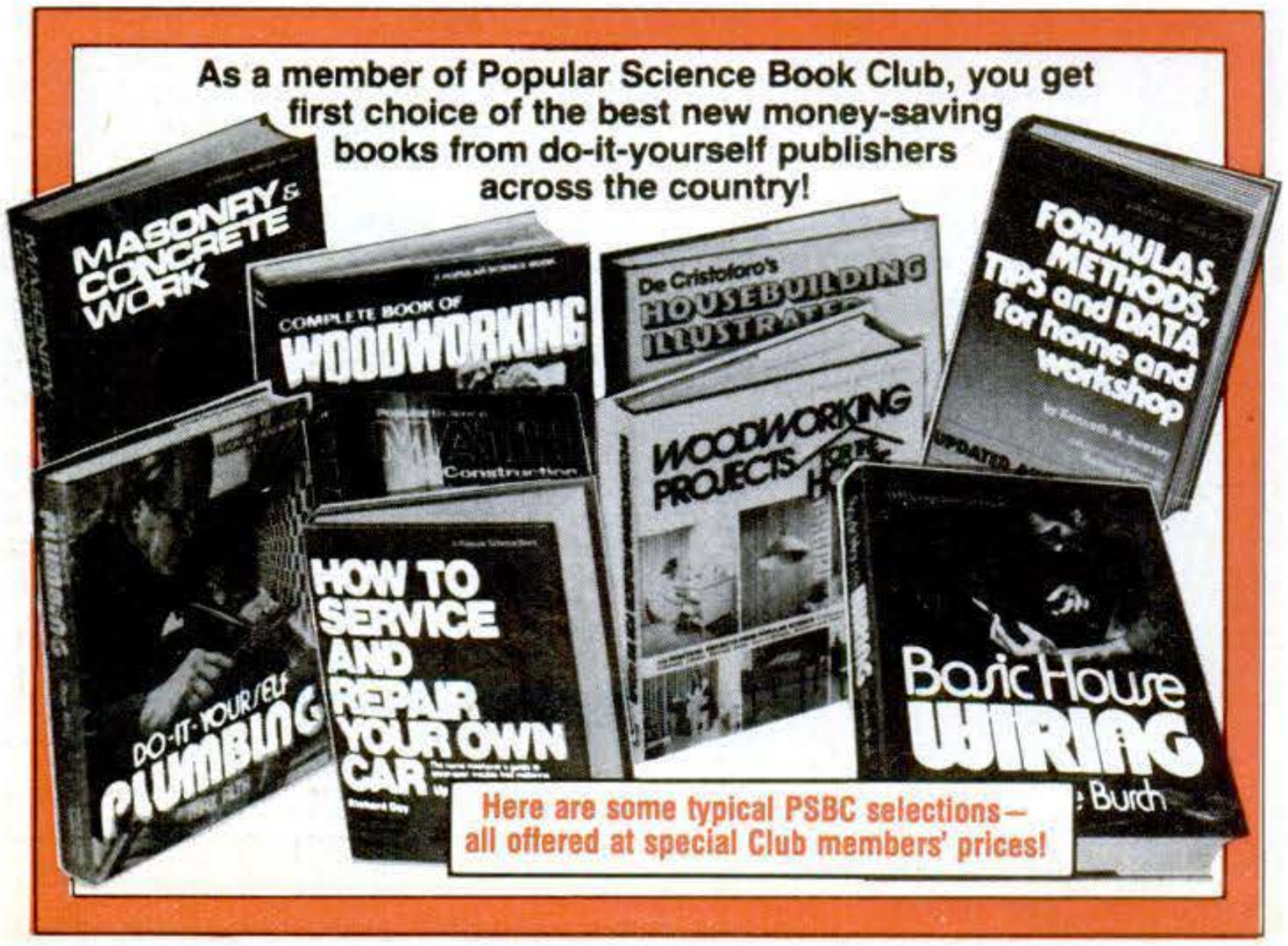

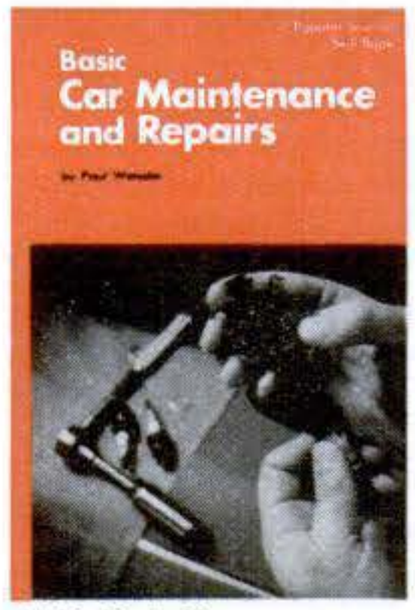

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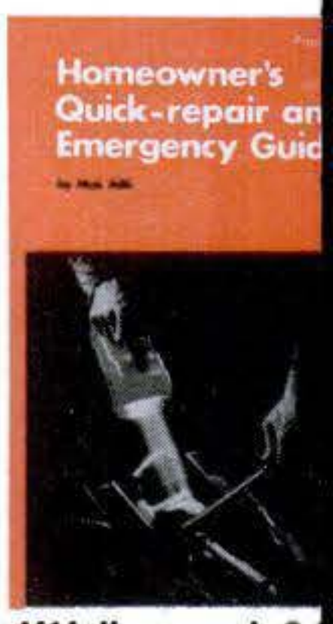

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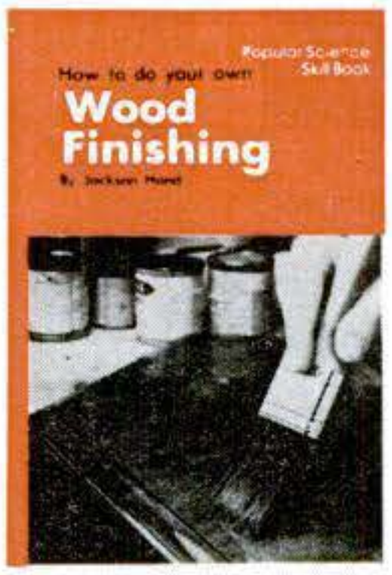

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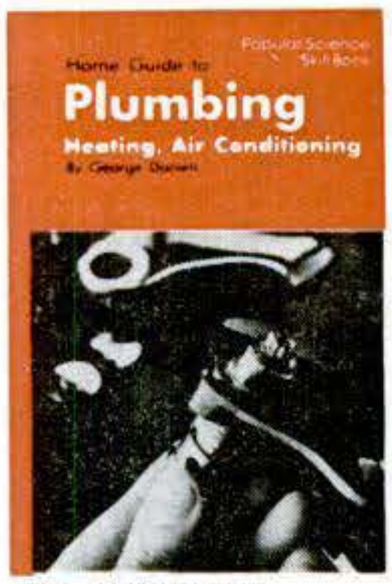

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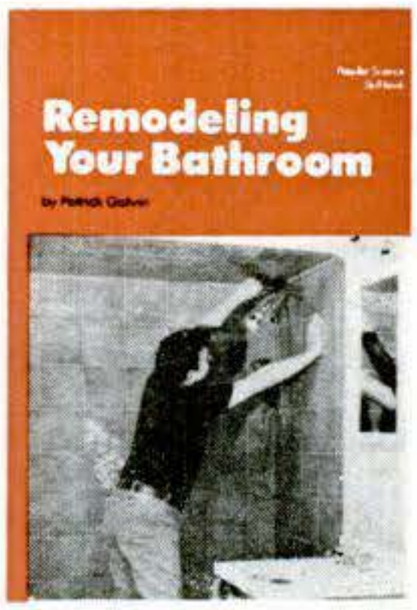

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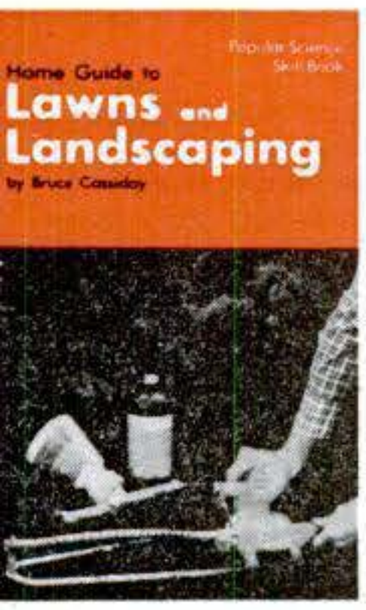

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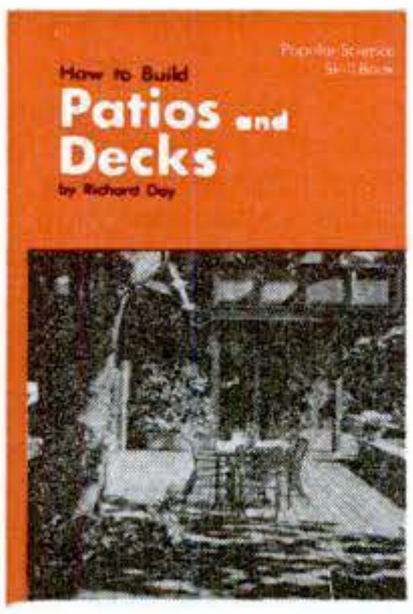

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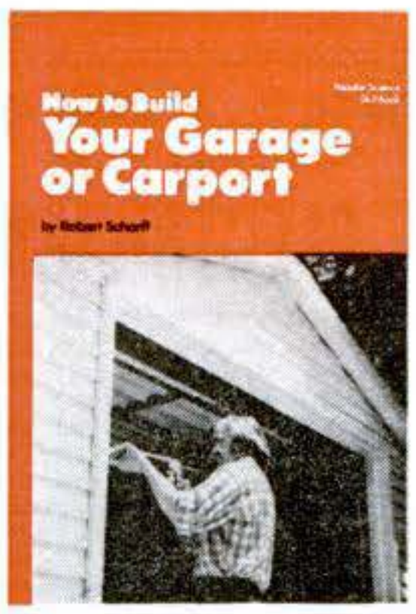

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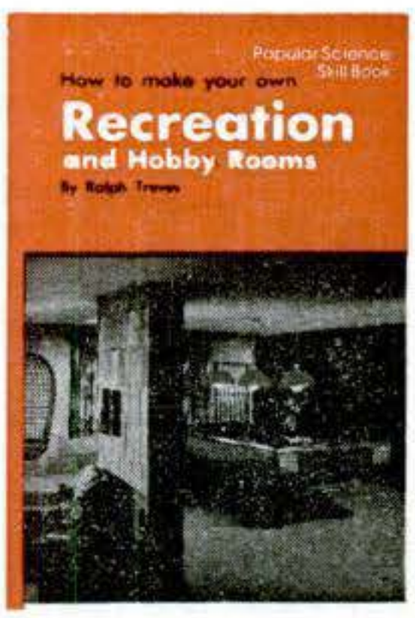

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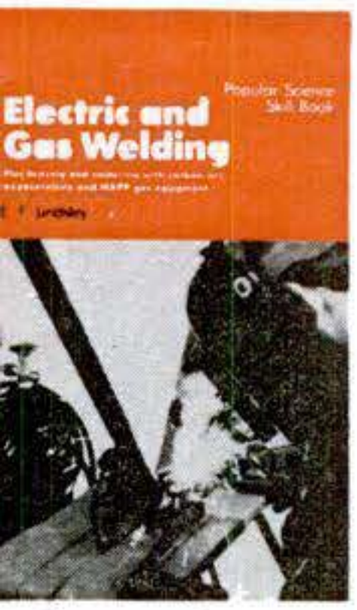

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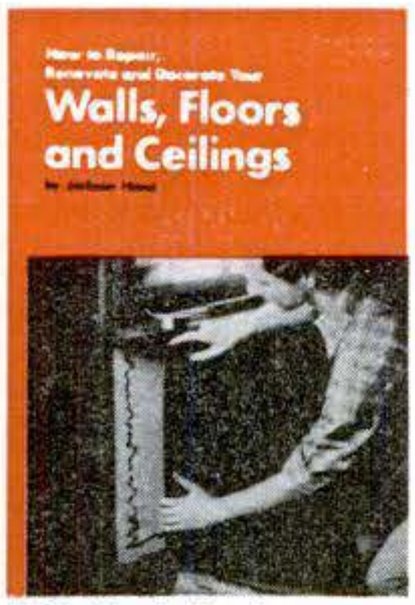

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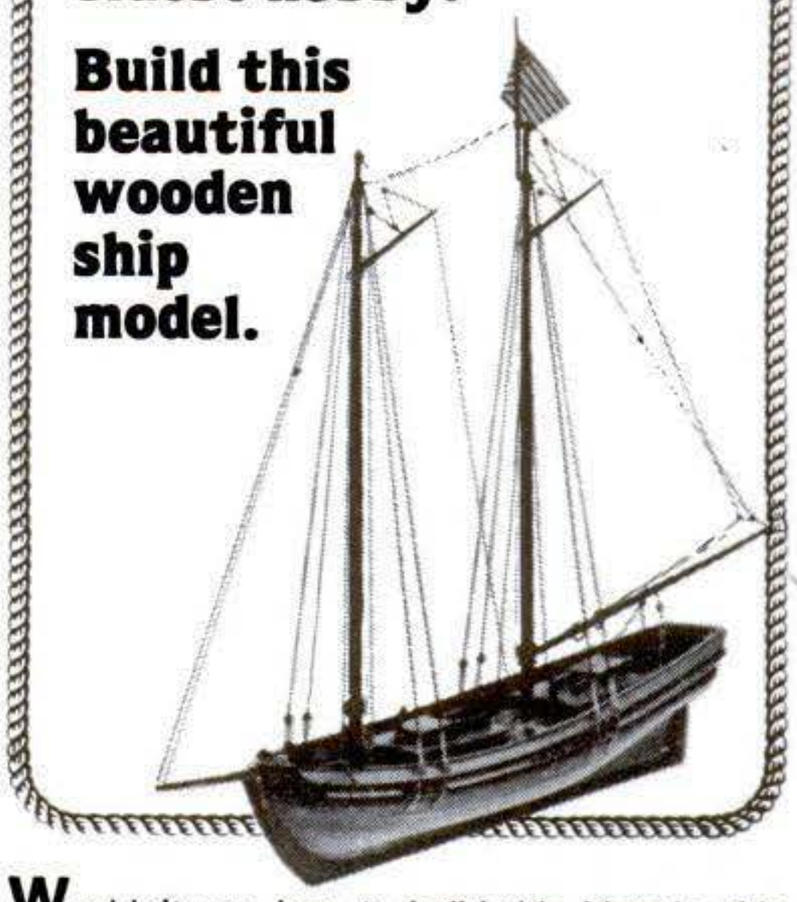

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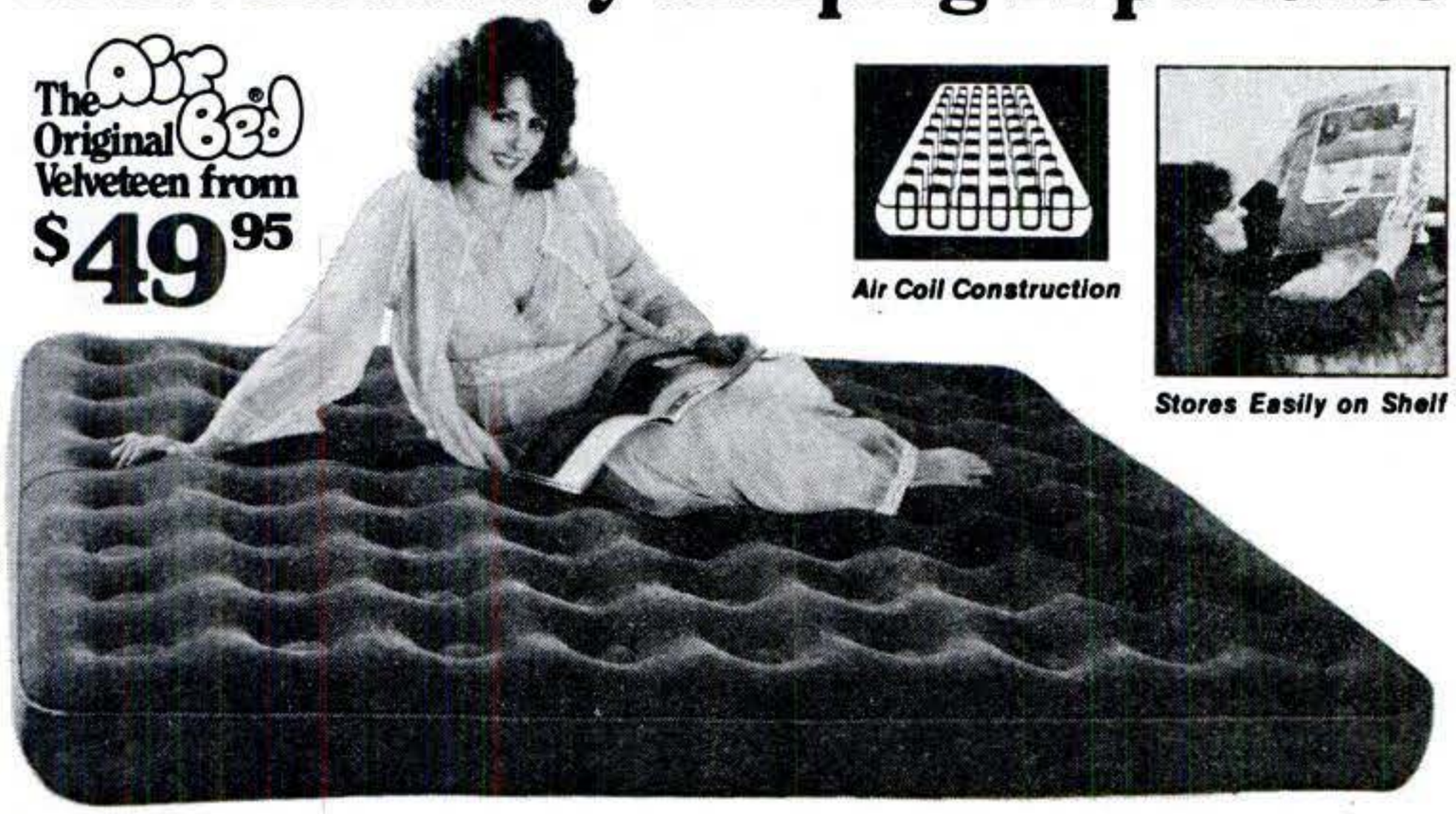

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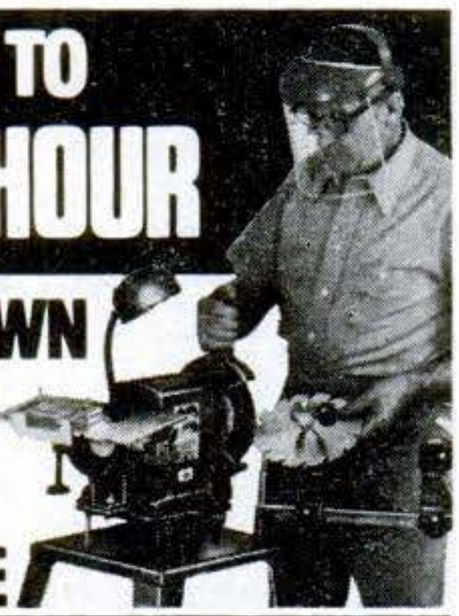

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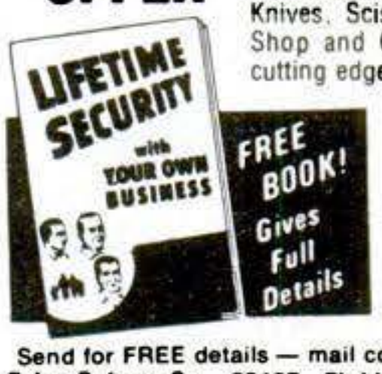

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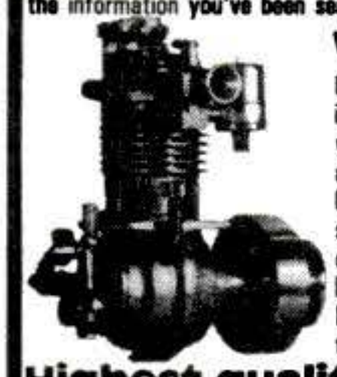

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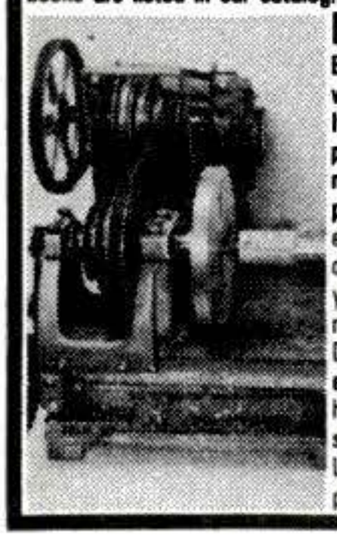

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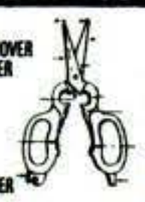

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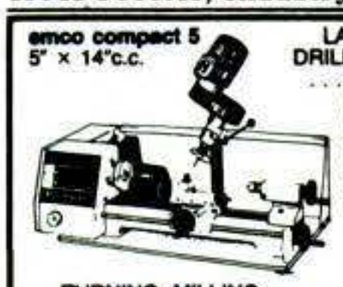

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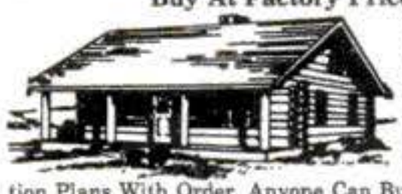

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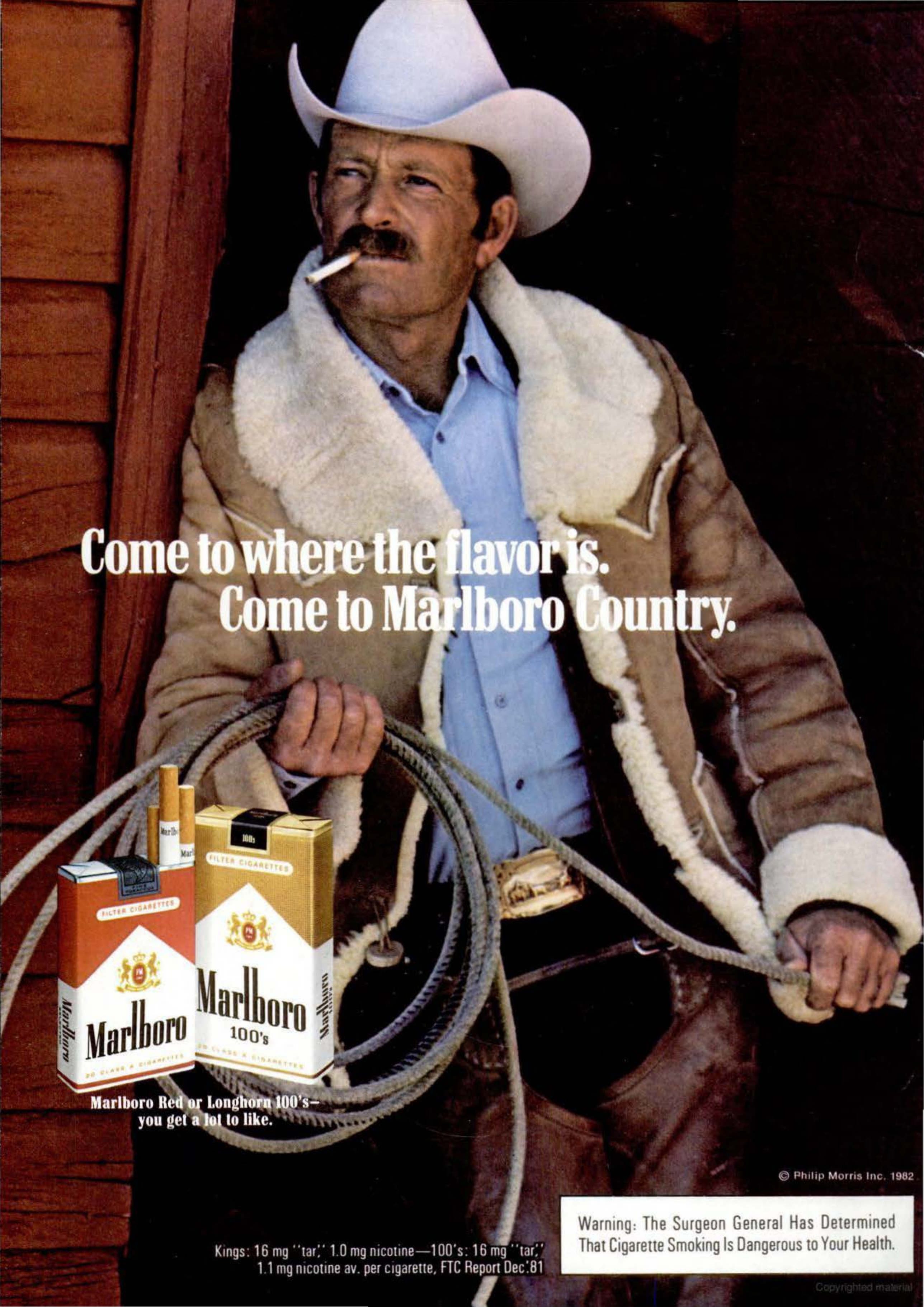

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